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SELECTED
 **WATER
RESOURCES
ABSTRACTS**



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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1990.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

S **lected Water Resources Abstracts**, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus**. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
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01 NATURE OF WATER

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02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

SPATIAL INTERRELATIONSHIPS BETWEEN TERRAIN, SNOW DISTRIBUTION AND VEGETATION PATTERNS AT AN ARCTIC FOOT-HILLS SITE IN ALASKA.

Pennsylvania State Univ., University Park. Environmental Resources Research Inst. B. M. Evans, D. A. Walker, C. S. Benson, E. A. Nordstrand, and G. W. Petersen. *Holarctic Ecology* HOECD2, Vol. 12, No. 3, p 270-278, Oct 1989. 7 fig, 2 tab, 16 ref.

Descriptors: *Terrain analysis, *Snow cover, *Vegetation, *Arctic zone, Mapping, Geographic information systems, Satellite technology, Alaska.

A multidisciplinary approach combining field surveys, aerial photographic techniques, digital terrain modelling, and geographic information system (GIS) technology was used to analyze spatial interrelationships at a study site in the northern foothills of the Brooks Range. The sensitivity of snow drifting to topography at the site is pronounced. The drift patterns indicate winter winds are predominantly from the south with a major secondary component from the southwest. These southwest winds are likely in conjunction with storm events. The deepest snow beds are found on the steeper, north-facing slopes. Snow also has an effect on vegetation that is evident at the scale of mapping (1:6000). Communities dominated by *Cassiope tetragona* are associated with deeper snow regimes, and may be useful indicators of deeper snow regimes even at much smaller scales because of their unique spectral signatures. The analyses conducted to date demonstrate the power of the GIS for analyzing terrain-geobotanical interrelationships, which will increase as we add new layers for other variables, and are able to correlate these with satellite data. (Author's abstract) W90-04714

FEEDBACK MECHANISM IN ANNUAL RAINFALL, CENTRAL SUDAN.

Khartoum Univ. (Sudan). Dept. of Civil Engineering. For primary bibliographic entry see Field 2B. W90-05005

PREDICTION OF GROUNDWATER FLOW AND MASS TRANSPORT USING LINEAR AND NONLINEAR ESTIMATION METHODS.

Stanford Univ., CA. Dept. of Civil Engineering. For primary bibliographic entry see Field 2F. W90-05201

RESULTS OF HYDROLOGIC RESEARCH AT A LOW-LEVEL RADIOACTIVE-WASTE DISPOSAL SITE NEAR SHEFFIELD, ILLINOIS.

Geological Survey, Champaign, IL. Water Resources Div. B. L. Louthian, and E. E. Gann. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-318, 1989. 124p, 61 fig, 4 tab, 65 ref.

Descriptors: *Radioactive waste disposal, *Land disposal, *Trenches, *Tritium, Microclimate, Evapotranspiration, Surface water, Runoff, Sediment transport, Collapse, Unsaturated flow, Soil saturation, Soil moisture retention, Saturated flow, Unconsolidated aquifers, Tracers, Water quality, Chemistry of precipitation, Geochemistry, Chemical reactions, Lysimeters, Tensiometers, Illinois.

Results of approximately 10 years of hydrologic research conducted by the U.S. Geological Survey at a commercial low-level, radioactive-waste disposal site near Sheffield, Illinois, are presented. Research included studies of microclimate, evapotranspiration, and tritium release by plants; runoff and land modification; water movement through a trench cover; gases in the unsaturated zone; water and tritium movement in the unsaturated and satu-

rated zones; and water chemistry. Implications specific to each research topic and those based on overlapped research topics are summarized as to their potential effect on the selection, characterization, design, operation, and decommissioning processes of future low-level radioactive-waste disposal sites. (USGS) W90-05221

HYDROLOGIC DATA COLLECTED IN THE VICINITY OF THE PROPOSED GAMMA-RAY AND NEUTRINO DETECTOR SITE, HOT SPRING COUNTY, ARKANSAS, 1988-89.

Geological Survey, Little Rock, AR. Water Resources Div. For primary bibliographic entry see Field 2F. W90-05268

APPLICATION OF THE PRECIPITATION-RUNOFF MODELING SYSTEM TO THE AH-SHI-SLE-PAH WASH WATERSHED, SAN JUAN COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div. H. R. Hejl. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. Water-Resources Investigations Report 88-4140, Nov. 1989. 36p, 7 fig, 5 tab, 17 ref.

Descriptors: *Model studies, *Rainfall-runoff relationships, *New Mexico, Ah-shi-sle-pah Wash, San Juan County.

The precipitation-runoff modeling system was applied to the 8.21 sq-mi drainage area of the Ah-shi-sle-pah Wash watershed in northwestern New Mexico. The calibration periods were May to September of 1981 and 1982, and the verification period was May to September 1983. Twelve storms were available for calibration and 8 storms were available for verification. For calibration A (hydraulic conductivity estimated from onsite data and other storm-mode parameters optimized), the computed standard error of estimate was 50% for runoff volumes and 72% of peak discharges. Calibration B included hydraulic conductivity in the optimization, which reduced the standard error of estimate to 28% for runoff volumes and 50% for peak discharges. Optimized values for hydraulic conductivity resulted in reductions from 1.00 to 0.26 in/h and 0.20 to 0.03 in/h for the 2 general soils groups in the calibrations. Simulated runoff volumes using 7 of 8 storms occurring during the verification period had a standard error of estimate of 40% for verification A and 38% for verification B. Simulated peak discharge had a standard error of estimate of 120% for verification A and 56% for verification B. Including the eighth storm which had a relatively small magnitude in the verification analysis more than doubled the standard error of estimating volumes and peaks. (USGS) W90-05272

APPLICATION OF THE PRECIPITATION-RUNOFF MODELING SYSTEM TO THE AH-SHI-SLE-PAH WASH WATERSHED, SAN JUAN COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div. H. R. Hejl. Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4140, 1989. 36p, 7 fig, 5 tab, 17 ref.

Descriptors: *Precipitation, *Rainfall-runoff relationships, *New Mexico, *Model studies, *Runoff, *Hydrologic models, Ah-Shi-Sle-Pah Wash, Watersheds, Flood peak, Hydraulic conductivity, Simulation analysis.

A deterministic precipitation-runoff model, the precipitation-runoff modeling system, was applied to the 8.21 sq mi drainage area of the Ah-shi-sle-pah Wash watershed in northwestern New Mexico (an arid climate). Emphasis was on calibrating model parameters in the storm mode using rainfall-runoff data collected at 5-minute intervals. The calibration periods were May through September

of 1981 and 1982, and the verification period was May through September of 1983. Twelve storms (maximum approximately 5-yr recurrence interval) were available for calibration and eight storms (maximum approximately 100-yr recurrence interval) were available for verification. For calibration A (hydraulic conductivity estimated from onsite data and other storm-mode parameters optimized), the computed standard error of estimate was 50% for runoff volumes and 72% for peak discharges. Calibration B included hydraulic conductivity in the optimization, which reduced the standard error of estimate to 28% for runoff volumes and 50% for peak discharges. When optimized, the values for hydraulic conductivity were significantly smaller than the values estimated from onsite data. Optimized values for hydraulic conductivity resulted in reductions from 1.00 to 0.26 in/hr and from 0.20 to 0.03 in/hr for the two general soil groups in the calibrations. Simulated runoff volumes using seven of eight storms occurring during the verification period had a standard error of estimate of 40% for verification analysis A and 38% for verification analysis B. Simulated peak discharges had a standard error of estimate of 120% for verification A and 56% for verification B. Including the eighth storm, which had a relatively small magnitude, in the verification analyses more than doubled the standard error of estimating volumes and peaks. (Author's abstract) W90-05547

DOCUMENTATION OF A COMPUTER PROGRAM TO SIMULATE STREAM-AQUIFER RELATIONS USING A MODULAR, FINITE-DIFFERENCE, GROUND-WATER FLOW MODEL.

Geological Survey, Carson City, NV. Water Resources Div. D. E. Prudic.

Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 88-729, 1989. 113p, 16 fig, 2 tab, 6 ref, 3 append.

Descriptors: *Surface-groundwater relations, *Streamflow, *Computer programs, *Computer models, *Model studies, *Hydrologic models, Finite difference methods, Simulation analysis, Flow profiles, Model studies.

Computer models are widely used to simulate groundwater flow for evaluating and managing the groundwater resource of many aquifers, but few are designed to also account for surface flow in streams. A computer program was written for use in the US Geological Survey modular finite difference groundwater flow model to account for the amount of flow in streams and to simulate the interaction between surface streams and groundwater. The new program is called the Streamflow-Routing Package. The Streamflow-Routing Package is not a true surface water flow model, but rather is an accounting program that tracks the flow in one or more streams which interact with groundwater. The program limits the amount of groundwater recharge to the available streamflow. It permits two or more streams to merge into one with flow in the merged stream equal to the sum of the tributary flows. The program also permits diversions from streams. The groundwater flow model with the Streamflow-Routing Package has an advantage over the analytical solution in simulating the interaction between aquifer and stream because it can be used to simulate complex systems that cannot be readily solved analytically. The Streamflow-Routing Package does not include a time function for streamflow but rather streamflow entering the modeled area is assumed to be instantly available to downstream reaches during each time period. This assumption is generally reasonable because of the relatively slow rate of groundwater flow. Another assumption is that leakage between streams and aquifers is instantaneous. This assumption may not be reasonable if the streams and aquifers are separated by a thick unsaturated zone. Documentation of the Streamflow-Routing Package includes data input instructions; flow charts, narratives, and listings of the computer program for each of four modules; and input data

Field 2—WATER CYCLE

Group 2A—General

sets and printed results for two test problems, and one example problem. (Lantz-PTT)
W90-05548

USE OF TEMPERATURE PROFILES BENEATH STREAMS TO DETERMINE RATES OF VERTICAL GROUND-WATER FLOW AND VERTICAL HYDRAULIC CONDUCTIVITY.

W. W. Lapham.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2337, 1989. 35p, 32 fig, 6 tab, 25 ref.

Descriptors: *Water temperature, *Surface-groundwater relations, *Hydraulic conductivity, *Groundwater movement, Thermal properties, Vertical flow, Geohydrology, Massachusetts, New Jersey, Flow velocity.

The use of temperature profiles beneath streams to determine rates of vertical groundwater flow and effective vertical hydraulic conductivity of sediments was evaluated at three field sites by use of a model that numerically solves the partial differential equation governing simultaneous vertical flow of fluid and heat in the Earth. The field sites are located in Hardwick and New Braintree, MA, and in Dover, NJ. In New England, stream temperature varies from about 0 to 25 C during the year. This stream temperature fluctuation causes groundwater temperatures beneath streams to fluctuate by > 0.1 C during a year to a depth of about 35 ft in fine-grained sediments and to a depth of about 50 ft in coarse-grained sediments, if groundwater velocity is 0 ft/day. Upward flow decreases the depth affected by stream temperature fluctuation, and downward flow increases the depth. At the site in Hardwick, MA, groundwater flow was upward at a rate of < 0.01 ft/day. The maximum effective vertical hydraulic conductivity of the sediments underlying this site is 0.1 ft/day. Groundwater velocities determined at three locations at the site in New Braintree, MA, where groundwater discharges naturally from the underlying aquifer to the Ware River, ranged from 0.10 to 0.20 ft/day upward. The effective vertical hydraulic conductivity of the sediments underlying this site ranged from 2.4 to 17.1 ft/day. Groundwater velocities determined at three locations at the Dover, NJ, site, where infiltration from the Rockaway River into the underlying sediments occurs because of pumping, were 1.5 ft/day downward. The effective vertical hydraulic conductivity of the sediments underlying this site ranged from 2.2 to 2.5 ft/day. Independent estimates of velocity at two of the three sites are in general agreement with the velocities determined using temperature profiles. The estimates of velocities and conductivities from the temperature measurements generally fall within the ranges of expected rates of flow in, and conductivities of, the sediments encountered at the test sites. Application of the method at the three test sites demonstrates the feasibility of using the method to determine the rate of groundwater flow between a stream and underlying sediments and the effective vertical hydraulic conductivity of the sediments. (Author's abstract)
W90-05554

SIMULATION OF RAINFALL-RUNOFF RESPONSE IN MINED AND UNMINED WATERSHEDS IN COAL AREAS OF WEST VIRGINIA.

For primary bibliographic entry see Field 4A.
W90-05560

HYDROLOGY OF THE CASTLE LAKE BLOCKAGE, MOUNT ST. HELENS, WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div.
W. Meyer, and M. Sabol.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4272, 1989. 25p, 16 fig, 3 tab, 5 ref.

Descriptors: *Debris avalanches, *Volcanoes, *Mount St Helens, *Castle Lake, *Groundwater

movement, *Washington, *Surface-groundwater relations, Avalanches, Slug tests, Groundwater recharge, Hydrologic models, Groundwater budget.

The debris avalanche that occurred during the May 19, 1980, eruption of Mount St. Helens blocked South Fork Castle Creek and created Castle Lake. Stability of the blockage was of concern, and a digital model that simulates three-dimensional groundwater movement in the blockage was constructed as part of the analysis used in a follow-up study that assessed the blockage's stability. Slug test results in the debris avalanche deposits and model results indicate that the average horizontal hydraulic conductivity of the blockage material is approximately 2.5 ft/day, whereas the ratio of horizontal to vertical hydraulic conductivity is approximately 10 to 1. The model was calibrated to seasonally high groundwater levels and groundwater discharge. Model-predicted recharge rates for this time period were 0.97 cu ft/sec. Most of the recharge (81%) results from the infiltration of precipitation, whereas discharge by seeps through the blockage accounts for 81% of the total discharge. Because water levels under the crest of the blockage are higher than lake level, the movement of groundwater is toward the lake and the toe of the blockage. The model allows the water levels to be estimated at any location in the blockage. This information is required for making estimates of the stability of the blockage against failure by gravitational-induced or earthquake-induced slope failure, liquefaction, the process of seepage erosion, or by erosion. (Lantz-PTT)
W90-05599

2B. Precipitation

TEMPORAL AND SPATIAL VARIATIONS OF RAINFALL NEAR THE CENTERS OF TWO TROPICAL CYCLONES.

National Oceanic and Atmospheric Administration, Miami, FL. Hurricane Research Div.
R. W. Burpee, and M. L. Black.
Monthly Weather Review MWREAB, Vol. 117, No. 10, p 2204-2218, October 1989. 9 fig, 5 tab, 24 ref, 2 append.

Descriptors: *Storms, *Cyclones, *Rainfall, *Precipitation, *Rainfall distribution, Rainfall area, Temporal distribution, Spatial distribution, Weather, Radar, Hurricanes.

The Hurricane Research Division collected radar reflectivity data with a portable recorder attached to National Weather Service (NWS) WSR-57 radars as Hurricanes Alicia of 1983 and Elena of 1985 approached the coastline of the U.S. The reflectivity data were used to estimate rain rates for the eyewall region, including the rain-free eye, and the rainbands in the annular area outside the eyewall, but within 75 km of the center of the eye. The rain rates include reflectivity corrections that were based upon the variation of average returned power with range in four hurricanes. The temporal and spatial variations of rain rates were examined in the cores of Hurricanes Alicia and Elena. In Alicia, variations of area-averaged rain rate (R) in the eyewall region were caused by the growth and decay of mesoscale convective areas. In Elena, the life cycles of individual convective cells also accounted for large changes in the eyewall R. In both hurricanes, the time series of R in the rainband region was less variable than the eyewall R, because the rain- and region was larger than the eyewall and contained a smaller percentage of convection. The distribution of precipitation in the eyewall and rainband regions was asymmetric. For several hours early in the observing period, the maximum rain rates in the eyewall and rainband regions of Alicia occurred in the left-front quadrant relative to the storm motion. Then, the heaviest rain in the eyewall region shifted to the right-front quadrant and that in the rainband region moved to the right of the storm track. In Elena, the maximum rain rates in the eyewall and rainband regions remained in the right-front quadrant throughout the computational period. About 55% of the precipitation in Elena's eyewall region occurred in the right-front quadrant. (Author's abstract)

W90-04573

ACID DEPOSITION MODELING AND THE INTERPRETATION OF THE UNITED KINGDOM SECONDARY PRECIPITATION NETWORK DATA.

Hull Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-04579

GENERALIZED MULTIDIMENSIONAL MODEL FOR PRECIPITATION SCAVENGING AND ATMOSPHERIC CHEMISTRY.

Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-04580

MODELING OF ATMOSPHERIC TRANSPORT AND DEPOSITION OF TOXAPHENE INTO THE GREAT LAKES ECOSYSTEM.

Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W90-04581

INTERCOMPARISON OF LONG-TERM ATMOSPHERIC TRANSPORT MODELS; THE BUDGETS OF ACIDIFYING SPECIES FOR THE NETHERLANDS.

UKAEA Atomic Energy Research Establishment, Harwell (England). Environmental and Medical Sciences Div.
For primary bibliographic entry see Field 5B.
W90-04582

HEAVY ISOTOPE DEPLETION IN HURRICANE PRECIPITATIONS (APPAUVRISSEMENT EN ISOTOPES LOURDS DES PRECIPITATIONS LIEES AUX CYCLONES).

Universite de Franche-Comte, Besancon (France). Lab. de Geologie Structurale et Appliquee.
E. Nicole, C. Jussier, B. Blavoux, J. Coudray, and C. Eberschweiler.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 309, No. 11, p 1255-1260, October 12 1989. 2 fig, 1 tab, 15 ref. English summary.

Descriptors: *Precipitation, *Rainfall infiltration, *Hurricanes, *Isotope studies, *Chemistry of precipitation, *Atmospheric water, *Cyclones, Storms, Surface-groundwater relations.

Studies of heavy isotopes depleted during precipitation were performed near the Reunion, Comores, Madagascar, Guadeloupe and Martinique Islands. Cyclone-type precipitation may represent up to 60% of the average annual precipitation, as in January 1980 at Reunion Island during Cyclone Hyacinthe. The amount of rainfall and the isotopic composition of (18)O and (2)H of some precipitations were measured with various time steps, including rains from hurricane and cyclone events near tropical islands in the Caribbean Sea and Indian Ocean. In each case and whatever the time step, cyclonic precipitation exhibited extensive depletion of heavy isotopes. For example, at Reunion Island, the (18)O content depletion in rains (from November 1986 to March 1987) collected at 11 stations scattered over the Fournaise Volcano at different latitudes, ranged from 140% to 250%. It was lesser on the south slope, greater on the east coast of the island and on the summits. It is concluded that cyclone-associated precipitation infiltration could result in groundwater depletion of heavy isotopes, as compared to that yielded by noncyclonic precipitation. This may be applied in the case of volcanic islands where infiltration rates may be very high and circulation very rapid. (Friedmann-PTT)
W90-04589

MACRO-REGIONAL DEFINITION AND CHARACTERISTICS OF INDIAN SUMMER MONSOON RAINFALL, 1871-1985.

Sheffield Univ. (England). Dept. of Geography.

WATER CYCLE—Field 2

Precipitation—Group 2B

S. Gregory.
International Journal of Climatology IJCLEU,
Vol. 9, No. 5, p 465-483, September/October 1989.
7 fig, 6 tab, 21 ref, append.

Descriptors: *Monsoons, *Rainfall, *Precipitation,
*India, *Storms, *Climates, Weather, Meteorologi-
cal data collection, Climatology, Air-water inter-
faces, Rainfall distribution, Tropical regions.

Regional-scale Indian summer monsoon rainfall data and analysis, intermediate between the widely used all-India and meteorological subdivision data sets were studied. Macro-regional units were constructed, 10 being defined using principal components analysis and a classification algorithm. The temporal changes of summer monsoon rainfall over the period 1871-1985 were analyzed and described for each of these regions, and the marked diversity of fluctuations between the regions was emphasized by a variety of methods. The degree of relationship was considered for each region between drier and wetter conditions and (1) El Nino and non-El Nino years, and (2) SST anomalies in the eastern tropical Pacific. Clear regional differences were apparent, but even statistically highly significant relationships were not large in any absolute sense. There is a need for explanatory analyses at the regional scale, in addition to those at the more common all-India scale. (Author's abstract) W90-04594

STATISTICAL DISTRIBUTION OF DAILY RAINFALL AND ITS ASSOCIATION WITH THE COEFFICIENT OF VARIATION OF RAINFALL SERIES.

Indian Inst. of Tropical Meteorology, Poona.
R. Ananthakrishnan, and M. K. Soman.
International Journal of Climatology IJCLEU,
Vol. 9, No. 5, p 485-500, September/October 1989.
8 fig, 6 tab, 13 ref.

Descriptors: *Statistical methods, *Rainfall, *Precipitation, *Rainfall intensity, *Rainfall area, *Meteorological data, Mathematical studies, Weather, Weather data, India, Rainfall rate.

The statistical analysis of the daily rainfall series (monthly, seasonal, and annual) of 15 Indian stations, representing a wide variety of rainfall regimes, utilizing the data for the period 1901-1980, was investigated. Attention is focused on the normalized rainfall curve (NRC) depicting the association between cumulated percentage rain amount and cumulated percentage number of rain days of the rainfall series. It was shown that the NRC is uniquely determined by the coefficient of variation (CV) of the rainfall series. There was no universal NRC that can represent all rainfall regimes. A good analytical representation of the NRCs over a wide range of CV values of the rainfall series is given. This analytical equation was able to account for the occurrence of high rainfall intensities toward the upper extremity of the NRC for rainfall series with high values of CV. The rain intensity corresponding to any point on the NRC was inversely proportional to the slope of the tangent at that point. The point where the slope is 45 degrees corresponds to the mean rain amount per rain day (\bar{r}) of the rainfall series. It was shown that days with rain amount greater than \bar{r} (considered as days of significant rainfall) constitute about 30 percent of the rain days and contribute 75-80% of the total rain amount, with some local and seasonal variations. (Author's abstract) W90-04595

MORPHOLOGY OF BISTABLE 180-DEGREE PHASE SWITCHES IN 18.6-YEAR INDUCED RAINFALL OVER THE NORTH-EASTERN UNITED STATES OF AMERICA.

State Univ. of New York at Stony Brook. Inst. for Atmospheric Sciences.
R. G. Currie, and D. P. O'Brien.
International Journal of Climatology IJCLEU,
Vol. 9, No. 5, p 501-525, September/October 1989.
17 fig, 4 tab, 45 ref.

Descriptors: *Rainfall, *Air circulation, *Atmospheric physics, *Atmosphere, *Climatology, *Weather patterns, Weather, Precipitation, Cli-

mates, Dendrochronology, Meteorological data collection.

Using a novel data presentation technique, bistable 180-degree phase switches in 18.6-year induced precipitation over the northeastern U.S. were re-examined. It was found that bistable switching in 19-yr wavetrains occurred principally at epochs 1898.9, 1917.5, and 1954.7, although some occurred at mid-epoch 1908.2, and at epochs 1936.1 and 1973.3 (epochs are dates of maximum in the lunar 18.6-year tide). The 180-degree phase switch at 1898.9 occurred along the northern Atlantic seaboard, and by epoch 1954.7, this invading 'cell' from the east blanketed virtually the entire region. A construct in mathematical physics has been provided which can explain how such sudden readjustments in the standing wave pattern for air pressure occur on subcontinental scales, and such adjustments are found in other climatic parameters such as air temperature and pressure. Results for seven tree-ring chronologies in the region are also given, and are found to have serious inconsistencies both among themselves and also with respect to instrumental rain-gauge data. (Author's abstract) W90-04596

EVOLUTION OF RAINDROP SPECTRA: PART II. COLLISIONAL COLLECTION/BREAKUP AND EVAPORATION IN A RAINSHAFT.

Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
S. Tzivion, G. Feingold, and Z. Levin.
Journal of the Atmospheric Sciences JAHSAK,
Vol. 46, No. 21, p 3312-3327, November 1, 1989. 8 fig, 1 tab, 23 ref, 2 append.

Descriptors: *Rain, *Atmospheric water, *Atmospheric physics, *Hydrologic cycle, *Air circulation, *Evaporation, Numerical analysis, Rainfall impact, Entrainment, Mathematical models.

The evolution of raindrop spectra with altitude through collisional collection/breakup sedimentation and evaporation is presented. Two-moment treatment of sedimentation and evaporation is developed to complement the first article of this series. An accurate, stable numerical scheme was obtained for evaporation that enables the investigation of the effect of evaporation on spectra subject to entrainment of strongly subsaturated air (including ventilation). The method includes provision for treatment of the variation of the sub/supersaturation within a time step in a dynamical framework. Results confirm that steady-state raindrop spectra are characterized by a bimodal or trimodal structure that becomes evident shortly after evolution commences. After sufficient evolution, peaks become clearly defined at 0.25 mm and 0.8 mm and further evolution with altitude affects only the relative magnitude of these peaks. It is shown that the evaporation process is not only dependent on the subsaturation of ambient air, but is also strongly dependent on the shape of the drop spectrum. Evaporation tends to increase the number of the smallest raindrops (< 0.1 mm) at the expense of the larger drops but does not modify the position of the peaks. The effect of drop spectral evolution on radar reflectivity (Z) and scavenging profiles was studied, and it was found that values of the scavenging coefficient are more dramatically reduced by evaporation than the reflectivity profiles. This is associated with the strong rate of evaporation of the smaller drops. In the case of the exponential distribution, the effect of evaporation is to reduce the small to medium-size drops and reverse the steady increase in scavenging at the upper levels. (Author's abstract) W90-04597

FACTORS GOVERNING THE TOTAL RAINFALL YIELD FROM CONTINENTAL CONVECTIVE CLOUDS.

Hebrew Univ. of Jerusalem (Israel). Dept. of Atmospheric Sciences.
D. Rosenfeld, and A. Gaglin.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 10, p 1015-1030, 1989. 16 fig, 11 tab, 25 ref.

Descriptors: *Rainfall, *Cloudbursts, *Convective precipitation, *Atmospheric physics, *Cloud liquid

water, Clouds, *Storms, Precipitation, Weather, Atmospheric water, Rainstorms.

Several important factors that govern the total rainfall from continental convective clouds were investigated by tracking thousands of convective cells in Israel and South Africa. The rainfall volume yield of the individual cells that build convective rain systems has been shown to depend mainly on the cloud-top height. There is, however, considerable variability in this relationship. The following factors that influence the rainfall volume yield were parameterized and quantitatively analyzed: (1) cloud base temperature. It is shown that when other factors are fixed, a 50% increase in the absolute humidity of the cloud base will nearly double the rainfall volume yield. (2) Atmospheric instability. Cells in a more unstable atmosphere will rain much less (up to a factor of 5) than cells that are forced to grow to a similar maximum height in a more stable atmosphere. It is suggested that more stable cells rain more because they grow more slowly, so that there is enough time for the cloud water to be converted into precipitation particles. (3) The extent of isolation of the cell. It is shown that isolated cells precipitate only about one-third of the rainfall volume yield of highly clustered cells, with the other factors being identical. It is also shown that a strong low level forcing increases the duration of the rainfall volume yield of clouds reaching the same vertical extent. (Author's abstract) W90-04598

OBSERVATIONS AND NUMERICAL SIMULATIONS OF PRECIPITATION DEVELOPMENT IN SEEDED CLOUDS OVER THE SIERRA NEVADA.

Wyoming Univ., Laramie.
For primary bibliographic entry see Field 7C.
W90-04599

EFFECTS OF CLOUD SEEDING IN WEST TEXAS.

Hebrew Univ. of Jerusalem (Israel). Dept. of Atmospheric Sciences.
D. Rosenfeld, and W. L. Woodley.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 10, p 1050-1080, 1989. 11 fig, 13 tab, 25 ref, append.

Descriptors: *Cloud seeding, *Cloud liquid water, *Weather modification, *Texas, *Atmospheric water, *Convective precipitation, *Clouds, Precipitation, Radar, Remote sensing, Rain.

The effect of randomized seeding with droppable silver iodide (AgI) flares in West Texas during the Southwest Cooperative Program is addressed. Attention is focused on individual convective cells and on the small mesoscale convective clusters that contain the cells. Analysis of three-dimensional, volume-scan, C-band radar data using sophisticated tracking software indicates that AgI seeding increased the areas, durations and rain volumes of the cells. The radar-estimated rainfall volume of bases of the AgI-treated cells was more than double the rain volume from the cells that received simulated treatment. In moving from the cell scale to the larger scales, it was found that cell merger occurred twice as often in the AgI-treated cases. Merging was most pronounced for cells treated early in their lifetimes with 9 or more AgI flares. The next step focused on the areas in which the cells received treatment. This 'focused area' approach involved calculations for radii of 5, 7, 10, 15, 20, 25 and 35 km around each treatment position, providing eight separate analyses. The rainfalls from the seeded cells exceeded the rainfalls from the non-seeded cells in the focused area by over 50% by the end of the analysis period. These results are consistent with a positive effect of AgI treatment on rainfall that begins on the cell scale, where the seeding takes place, and spreads into the overall experimental unit with time. The final step in the study involved examination of the experimental units themselves. The ratios of Seed (S) to No Seed (NS) rainfalls by half-hour interval and cumulatively generally exceeded a factor of 1.20 for the two approaches employed by the analyses.

Field 2—WATER CYCLE

Group 2B—Precipitation

It is recommended that the sample be expanded further and that subsequent analyses include the use of predictive equations to reduce the impact of the natural rainfall variability. (Author's abstract) W90-04600

ESTIMATES OF PRECIPITATION EMBRYO DENSITIES USING MEASUREMENTS FROM AN AIRCRAFT RADAR.

CloudQuest Ltd., Nelspruit (South Africa).
G. K. Mather.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 10, p 1089-1097, 1989. 7 fig, 11 ref.

Descriptors: *Rain, *Cloud liquid water, *Radar, *Atmospheric water, *Remote sensing, Precipitation, Rainfall, Clouds, Ice.

Determination of the habits (ice or water) and, therefore, the densities of particles whose images are acquired by 2D probes, is often an ambiguous process. A Learjet's radar measurements of equivalent reflectivity factors from a range gate 1800 m ahead of the aircraft were compared to reflectivities calculated from images acquired by a 2D-C probe over a range of assumed particle densities from 0.2 to 1 g/cu cm. Although the comparisons suffer from many uncertainties, such as the vast disparity between the volumes sampled by the 2D-C probe and the aircraft radar, the method does discriminate well between water drops of recently frozen riming water drops and low density graupel particles. (Author's abstract) W90-04601

MESO-GAMMA-SCALE DISTRIBUTION OF OROGRAPHIC PRECIPITATION: NUMERICAL STUDY AND COMPARISON WITH PRECIPITATION DERIVED FROM RADAR MEASUREMENTS.

Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
P. Alpert, and H. Shafir.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 10, p 1105-1117, 1989. 7 fig, 3 tab, 19 ref.

Descriptors: *Meteorology, *Climatology, *Model studies, *Rainfall distribution, *Numerical analysis, Mathematical models, *Radar, *Rainfall, *Orographic precipitation, Meteorological data collection, Precipitation.

On the assumption that moisture convergence due to mechanical uplifting approximately equals the orographic precipitation, the meso-gamma-scale rainfall distributions over mountainous regions in Israel are investigated. The simulated distributions are compared to rainfall observations both from rain gauges and from radar reflectivities. The mean error in the predicted rainfall on scale of 2 km was $\pm 8.4\%$ for mean annual normals and $15\%-20\%$ for three case studies. It is suggested that orographic rainfall on the small mesoscale is highly predictable with the adiabatic assumption that the uplifting is determined by a mathematical expression that accounts for the horizontal wind encountering the mountain and the topographic elevation. It is also illustrated that the climatological observed rainfall distribution could be complemented by the model at locations where sufficient observations were not available. By comparison of the model simulation with the radar-derived rainfall, the considerable effect that a change in the wind direction has on the orographic rainfall distributions is shown. (Author's abstract) W90-04602

ESTIMATION OF AREAL RAINFALL USING THE RADAR ECHO AREA TIME INTEGRAL.
National Severe Storms Lab., Norman, OK.
R. E. Lopez, D. Atlas, D. Rosenfeld, J. L. Thomas, and D. O. Blanchard.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 11, p 1162-1175, November 1989. 11 fig, 1 tab, 41 ref. NASA Contract NASW-4252.

Descriptors: *Rainfall area, *Remote sensing, *Meteorology, *Rainfall rate, *Radar, *Statistical methods, *Rainfall, *Precipitation, *Data interpretation, Rainfall distribution, Regression analysis, Atmospheric water, Storms, Rainstorms, Florida.

The Area Time Integral (ATI) method, developed for the lifetime rainfall from an individual storm, and the instantaneous areawide rainfall method, were extended to the measurement of the cumulative areawide rainfall for periods up to 12 h. The database is the radar and rain gage network data for the three summers (1978, 1979, and 1980) of the Florida Area Cumulus Experiment (FACE) II. For 12-h accumulations (V) over a 36,000 sq km area, correlations of 0.92 were found between radar deduced rainfall and ATI where the ATI was computed at intervals from 5 min up to 1 h. The slope of the regression line $V/(ATI)$ is 3.4 mm/h. Using a gage network with density of 1/11 sq km over an area of 15,000 sq km, the correlation coefficient dropped to 0.84, still sufficiently high to confirm the validity of the ATI approach. With the gage data the $V/(ATI)$ slope decreased to 2.6 mm/h. The decrease in the correlation is due largely to anomalous propagation, which falsely increases storm areas, and partly to the poorer sampling by the gages. The decrease in the rain volume from radar to gage-determined values is probably due to: (1) underestimation of the rain cores by the spaced gages; (2) the use of the wide beam WSR-57 and low threshold for echo area measurements; and (3) an inappropriate reflectivity-rainfall relation. A comparison of the $V/(ATI)$ ratios using either radar or gage rainfall to the value expected theoretically on the basis of the probability distribution of rain rate at Miami showed that one should expect about twice the volume per unit echo area as those observed. This is also believed to be due to the wide beam and the low threshold that tends to enlarge the echo areas excessively. Improved correlations and better agreement with theory are expected at higher radar/rain rate thresholds and with narrower beams. (Author's abstract) W90-04603

DEVELOPING RAINFALL INSURANCE RATES FOR THE CONTIGUOUS UNITED STATES.

S. A. Changnon, and J. M. Changnon.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 11, p 1185-1196, November 1989. 9 fig, 3 tab, 11 ref.

Descriptors: *Rainfall distribution, *Spatial distribution, *Temporal distribution, *Rainfall rate, *Insurance, *Flood forecasting, Risks, Meteorological data collection, Climates.

Historical hourly rainfall data (1950-84) were subjected to spatial and temporal analyses to provide information for developing rainfall insurance rates for the contiguous United States. The dimensions of the study illustrate a balance between insurance needs, funding, and adequate climatic analyses. Assessment of the hourly rainfall data from 2092 stations in the United States revealed that only 211 had data deemed useful to this study. Seventeen regions with similar probabilities of rainfall (rate areas) were defined. The average patterns of hourly rainfall closely resemble the nation's average annual precipitation pattern. Separate seasonal rain-hour probabilities were defined throughout the United States because of marked differences between wetter and drier portions of the year. Temporal analyses of rain hours defined the length of record to use in rate determinations, and how often new rates should be calculated. Long-term trends were not present during 1950-84 in any area, and 78% of the 5-yr and 10-yr values were within $\pm 5\%$ of the long-term average, reflecting generally low interannual variability; however, 15% of these short-term fluctuations deviated greatly ($> 20\%$) from average. Results led to the recommendation that rerating should be done once every 5 years in most rate areas, and that values of the most recent 25 years should be used for rating. Analysis of in-day hourly rain probabilities revealed major diurnal differences existed during the wet seasons in the central and southeastern United States, and different (night and day) rates were recommended. (Author's abstract) W90-04604

EFFECTS OF DIFFERENT RAIN PARAMETERIZATIONS ON THE SIMULATION OF

MESOSCALE OROGRAPHIC PRECIPITATION.

Observatoire de Physique du Globe de Clermont-Ferrand (France).
E. Richard, and N. Chaumerliac.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 11, p 1197-1212, November 1989. 14 fig, 1 tab, 27 ref, append.

Descriptors: *Cloud liquid water, *Orographic precipitation, *Clouds, *Meteorology, *Climatology, *Atmospheric water, *Rain, *Model studies, Precipitation, Stochastic process, Mathematical studies, Atmospheric physics, Simulation, Simulated rainfall.

A detailed comparison was made between the results obtained from two sets of microphysical parameters capable of simulating cloud and precipitation processes in a mesoscale model. One set of parameters makes use of an inverse exponential function and subdivides liquid water between cloud water and rainwater (Kessler scheme). The other set is derived from the stochastic coalescence equation, subdivides the liquid water as in the Kessler scheme, and adds an additional predictive equation for the raindrop number concentration (Berry and Reinhardt scheme). The behavior of each microphysical scheme was first investigated in the context of a mountain wave simulation. Major differences were found in raindrop size distributions as well as in the rates associated with various microphysical processes. An assessment of the accuracy of each scheme was then obtained by comparing model predictions with observational data from well-documented orographically enhanced precipitation episodes in South Wales. The parameters derived from the stochastic coalescence equation did a better job of reproducing the observed dependency of the precipitation enhancement on the low-level windspeed than did the Kessler scheme. Recommendations in favor of one or the other scheme for mesoscale modeling will depend on the problem to be addressed. The Berry and Reinhardt scheme is more appropriate to wet chemistry studies. For computations on the meso-alpha scale, especially when computational speed is a major concern such as in the production of operational forecasts, the Kessler parameter scheme may be preferable. (Freidmann-PTT) W90-04605

DIURNAL VARIATIONS DURING THE AUSTRALIAN MONSOON EXPERIMENT (AMEX) PHASE II.

Bureau of Meteorology, Melbourne (Australia). Research Centre.
T. D. Keenan, J. McBride, G. Holland, N. Davidson, and B. Gunn.
Monthly Weather Review MWREAB, Vol. 117, No. 11, p 2535-2552, November 1989. 10 fig, 1 tab, 30 ref.

Descriptors: *Climatology, *Meteorology, *Monsoons, *Air circulation, *Atmospheric water, *Clouds, *Remote sensing, *Weather patterns, *Tropical cyclones, *Australia, Weather, Radar, Cloud liquid water, Satellite technology, Tropical regions, Storms.

The diurnal variations in tropical cloudiness and tropospheric winds during the Australian Monsoon Experiment (AMEX) Phase II are documented and compared to those observed elsewhere. A diurnal variation in tropical cloudiness was a consistent feature of both disturbed and undisturbed conditions. The tropical cloudiness, as inferred from satellite and radar data, averaged over the entire period of AMEX Phase II, was at a maximum during the morning over the ocean and during the late afternoon over the Arnhem Land region of northern Australia. The diurnal variation in high cloud, as measured by satellite, was 3:2 over the ocean and 4:1 over Arnhem Land. Radar data indicated a 10:1 variation in convection over Arnhem Land, a 2:1 variation over the neighboring ocean and a 3:2 variation in the stratiform echoes over both Arnhem Land and the neighboring ocean. Interaction between local circulations and the large scale flow was found to be associated with the observed diurnal variations in tropical

cloudiness. The large scale monsoon circulation exhibited a diurnal oscillation with maxima in both the low-level easterly and equatorial westerly flow during the early morning. Variations in the vertical motion fields were in phase with the inferred cloudiness changes, but the midlevel maximum in vertical motion did not correspond with the strongest boundary layer convergence. The precise timing of maximum upward vertical motion over oceanic regions within the primary AMEX domain and the less reliably observed region to the north of Australia varied according to the degree of convective activity; consistent features were a maximum in vertical motion at 0830 LST during disturbed conditions and an 0230 LST maximum during suppressed conditions. (See also W90-04611) (Author's abstract)
W90-04610

AUSTRALIAN SUMMER MONSOON CIRCULATION DURING AMEX PHASE II.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
B. W. Gunn, J. L. McBride, G. J. Holland, T. D. Keenan, and N. E. Davidson.
Monthly Weather Review MWREAB, Vol. 117, No. 11, p 2554-2574, November 1989. 15 fig, 8 tab, 38 ref, append.

Descriptors: *Climatology, *Meteorology, *Monsoons, *Weather patterns, *Atmosphere, *Air circulation, *Australia, *Tropical cyclones, *Remote sensing, Satellite telemetry, Meteorological data collection, Radar, Storms.

The major field phase of the Australian Monsoon Experiment (AMEX Phase II) was conducted over northern Australia from 10 January to 15 February 1987. It was based on the collection of high-density tropical upper air soundings and radar data at 12 special observation sites. These were complemented by satellite and surface data, the existing upper air network, and two simultaneous aircraft based tropical experiments. The data collected in AMEX through upper air network, radar, satellite, numerical analysis, and observed surface data, and the mean and transient structure of the Australian Monsoon circulation during the experiment are described. In the upper levels, the equatorial easterly flow is slightly stronger and much broader in latitudinal extent than the climatology. The Northern Hemisphere subtropical jet, during AMEX, is far-poleward, corresponding to an active monsoon situation. Mean soundings across the network are compared with each other and with soundings from other commonly used research datasets. It is shown that an active monsoon trough lay through the AMEX network, and that the associated convection is located within one of the three global tropical heat sources. Active and inactive periods of monsoon behavior were defined. Monsoon onset occurred within the period of the experiment and four tropical cyclones existed within the enhanced network. Two of these developed inside an array of radiosondes surrounding the Gulf of Carpentaria. (See also W90-04610) (Author's abstract)
W90-04611

CHARACTERISTICS OF MESOSCALE PRECIPITATION BANDS IN SOUTHERN FINLAND.
Helsinki Univ. (Finland). Dept. of Meteorology.
P. Saarikivi.
Monthly Weather Review MWREAB, Vol. 117, No. 11, p 2584-2593, November 1989. 7 fig, 4 tab, 26 ref.

Descriptors: *Climatology, *Meteorology, *Precipitation, *Rainfall, *Rainfall distribution, *Rainfall area, *Finland, *Weather patterns, Atmospheric water, Weather data collections, Meteorological data collections, Weather, Radar, Remote sensing, Data interpretation.

A large amount of observational material, consisting of more than 3000 hours of radar measurements from about 150 cyclones, was analyzed to discover the characteristic features of banded structures in extratropical cyclones in southern Finland. All previously classified types of rain and snowbands have been observed. The most common rainband

types were warm frontal aloft, postfrontal, warm sector and occluded warm frontal bands. The average size parameters of different rainband types showed only slight variations from type to type. A distinct annual variation in the echo top height, rainband width and wavelength was found. The average echo top heights were 3 and 6.5 km, the wavelengths 29 and 77 km, and the widths 18 and 35 km in winter and summer, respectively. The monthly values of the ratio of wavelength to height were relatively constant. They varied between 6 and 14, averaging 11. (Author's abstract)
W90-04612

RAINFALL TIME SERIES FOR STORM OVERFLOW ASSESSMENT.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
R. J. Henderson.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1789-1791, 1989. 1 fig, 1 tab, 4 ref.

Descriptors: *Urban hydrology, *Rainfall-runoff relationships, *Combined sewers, *Storm-overflow sewers, *Sewers, *Storm runoff, *Model studies, Hydrologic models, Time series analysis, Mathematical studies, WASSP-SIM model, Storage, Water storage, Overflow, Design criteria.

Data from a combined sewer and its overflows were assessed using a simulation model of the system (WASSP-SIM), together with a rainfall time series representing a typical year of rainfall in the United Kingdom. It was concluded that the effectiveness of the storage volume was highly dependent on the temporal distribution, intensity, and duration of the storm event and that, in the design of storage facilities for combined sewers a rainfall series would be more appropriate than design storms. Modest storage was quite effective in containing the worst polluting discharges. (Cassar-PTT)
W90-04772

DESIGN RAINFALL CHARACTERISTICS FOR SOUTH-WEST SAUDI ARABIA.
Imperial Coll. of Science and Technology, London (England).

H. S. Wheatley, P. Larentis, and G. S. Hamilton.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 87, No. part 2, p 517-538, December 1989. 12 fig, 8 tab, 12 ref.

Descriptors: *Rainfall intensity, *Rainfall distribution, *Saudi Arabia, Wadi.

Short-term rainfall data from a comprehensive hydrometric network in south-west Saudi Arabia are analyzed with respect to intensity-duration-frequency and point to areal rainfall relationships. A complex regional pattern of rainfall intensity characteristics is identified, and station-year results are generally consistent with an analysis of selected long records from individual long-term gages. Areal reduction factors are similar to those from south-western USA. Results presented are significantly different from a recently published analysis for this region. A major difficulty in design procedure has been the lack of information on point to areal rainfall relationships, and results presented here provide a basis for design. An important observation from the rain gage networks has been the 'spottiness' of rainfall for all seasons. This is reflected in the areal reduction factors analysis presented, which are similar to results from convective rainstorms in the south-west USA. The higher estimates obtained by previous studies are difficult to accept in the light of observations, and may be due to a different analysis procedure. (Author's abstract)
W90-04989

REGIONALIZATION OF THUNDERSTORM RAINFALL IN THE CONTIGUOUS UNITED STATES.

Indiana Univ. at Bloomington. Dept. of Geography.
D. R. Easterling.
International Journal of Climatology IJCLEU, Vol. 9, No. 6, p 567-579, November/December

1989. 6 fig, 37 ref.

Descriptors: *Rainfall distribution, *Climatology, *Meteorology, *Thunderstorms, *Orographic precipitation, *Regional analysis, Seasonal variation, Spatial distribution, Probability distribution, Mathematical studies, Probable maximum precipitation, Convective precipitation, Meteorological data collections.

The amount of precipitation recorded during individual thunderstorms was determined at 220 stations in the contiguous United States of America for a 30-year period. The probability distribution of thunderstorm rainfall amounts at each station during each season was summarized by use of the incomplete gamma distribution. The incomplete gamma distribution is completely described by two parameters, which were used in a clustering routine to determine whether regionalizing tendencies exist in the probability distributions. Large-scale regions were found when the results of the clustering were mapped. The region most likely to produce heavy rainfall from a thunderstorm event during the spring, summer, and autumn includes the Southern Atlantic and Gulf Coasts, and extends northward into the Central Great Plains. The region tending to experience the lightest thunderstorm rainfall occurs in Western USA and the Northeastern states. Orographic effects are seen with the southward extension along the Appalachian ridge of a region with a tendency for lighter thunderstorm rainfall compared to the surrounding regions. In general, these regions corresponded well with the areas of dominance of many of the proposed mechanisms for thunderstorm development. (Author's abstract)
W90-04995

FIVE-YEAR RADAR CLIMATOLOGY OF CONVECTIVE PRECIPITATION FOR NEW JERSEY.

New Jersey Agricultural Experiment Station, New Brunswick.

P. J. Croft, and M. D. Shulman.
International Journal of Climatology IJCLEU, Vol. 9, No. 6, p 581-600, November/December 1989. 10 fig, 10 tab, 19 ref.

Descriptors: *Remote sensing, *Meteorology, *Rainfall distribution, *New Jersey, *Convective precipitation, *Climatology, *Rainfall intensity, Synoptic analysis, Regional analysis, Radar, Pennsylvania, Precipitation intensity, Thunderstorms.

A radar climatology of convective precipitation for New Jersey during the summer season (May-September) was developed using manually digitized radar (MDR) data from four local radar sites. Convective precipitation frequencies were determined by tabulating occurrences of echo intensity levels equal to 2 or more for each of 63 grid boxes located in and around New Jersey. Convective precipitation frequencies over a 5-yr period (1978-1982) were plotted by grid box, and isopleths of duration and intensity level were constructed. The distribution of the frequency of occurrence of convective activity was examined for thunderstorm (level 3 or more) occurrence and severe thunderstorm (level 5 or more) occurrence. The highest convective frequencies occurred over southeastern Pennsylvania while the greatest frequency of more intense convection occurred over south-central New Jersey. An analysis of variance was performed on the data set to determine the relative variability of convective precipitation in the grid. Year-to-year and week-to-week variability was high while intergrid-box variability was low. Duncan's multiple range test (DMRT) was applied to compared individual years to each other, and individual weeks to each other. When grid boxes were assigned to four climatological regions and DMRT applied, some regions were found to be significantly different from one another. No significant differences were found between grid boxes within each region. There was no interaction between grid regions and years as differences in mean convective activity between regions remained generally constant from year to year. The distribution of convective activity over New Jersey was determined by local climatological factors while the

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total frequency from year to year was determined by the mean synoptic pattern. (Author's abstract) W90-04996

RELATIONSHIPS BETWEEN THE SOUTHERN OSCILLATION AND THE RAINFALL OF SRI LANKA.

Tsukuba Univ. (Japan). Inst. of Geoscience.

R. Suppiah.

International Journal of Climatology IJCLEU, Vol. 9, No. 6, p 601-618, November/December 1989. 11 fig, 7 tab, 36 ref.

Descriptors: *Climatology, *El Nino/Southern oscillation, *Sri Lanka, *Monsoons, *Rainfall, Statistical analysis, Seasonal variation, Tropical regions, Model studies, Regional analysis, Spatial distribution, Topography, Temporal distribution.

The Southern Oscillation signals in the monthly and seasonal rainfall of Sri Lanka were studied by statistical analyses. Correlation coefficients between the rainfall of the first intermonsoon season (March-April) and the seasonal Southern Oscillation Index of August-September-October (ASO) and November-December-January (NDJ) are positive and significant. In particular, March rainfall in region A (southeastern Sri Lanka) is significantly correlated with the subsequent Southern Oscillation Index of ASO and NDJ. The correlation coefficients between the rainfall of the southwest monsoon season (May-September) and the Southern Oscillation Index is also positive. Cumulative rainfall of the peak monsoon months (July and August) reveals a strong and positive correlation with the seasonal Southern Oscillation Index. The correlation coefficient between the rainfall of the second intermonsoon season (October-November) and the Southern Oscillation Index is negative and significant. The rainfall of this season is also significantly correlated with the Southern Oscillation Index (Tahiti-Darwin) of May-June-July (MJJ). The Southern Oscillation Index of MJJ serves as a particularly useful predictor for this seasonal rainfall. The correlation coefficient between the rainfall of the northeast monsoon season (December-February) and the Southern Oscillation Index is also negative but weak. Large signals appear in wind anomalies over Sri Lanka prior to El Nino/Southern Oscillation (ENSO) events. Upper level easterlies (westerlies) and weak (strong) low-level easterlies are dominant in March before the La Nina (El Nino) years. These wind anomalies persist until the ENSO events reach maturity. Based on the results of correlation analysis and wind anomalies, schematic models of the zonal circulation along the Equator between 60 degrees east and 140 degrees west are presented for La Nina and El Nino phases for northern hemispheric summer and winter seasons. (Author's abstract) W90-04997

HAWAIIAN DROUGHT AND THE SOUTHERN OSCILLATION.

Hawaii Univ., Honolulu. Dept. of Meteorology. P. S. Chu.

International Journal of Climatology IJCLEU, Vol. 9, No. 6, p 619-631, November/December 1989. 6 fig, 4 tab, ref.

Descriptors: *El Nino/Southern oscillation, *Climatology, *Model studies, *Drought, *Rainfall, *Hawaii, Statistical analysis, Wind, Evaporation, Seasonal variation, Temperature effects, Synoptic analysis.

Long-term rainfall records at key locations on the Hawaiian Islands and the Southern Oscillation Index are examined to reveal the impact of large-scale atmospheric circulation on Hawaiian rainfall. By compositing six major drought winters, it is found that they were preceded by a persistently low phase of the Southern Oscillation starting from March of the preceding year. Correlation analysis indicates that the spring Southern Oscillation Index is not significantly correlated to rainfall in the subsequent seasons. In contrast, changes of the Southern Oscillation Index in summer lead to corresponding changes of rainfall by two to three seasons. Similarly, changes of the Southern Oscillation Index in autumn lead to changes of rainfall

by one to two seasons. These results are also confirmed by scatter diagrams. Although a large negative Southern Oscillation Index anomaly in summer or autumn can be regarded as a precursor to a drought for the following winter or spring, the inverse relation, namely, a positive Southern Oscillation Index anomaly leading to abundant rainfall does not necessarily follow. As an empirical rule, a value for the summer Southern Oscillation Index of -2 or below, or a value for the autumn Southern Oscillation Index of -1 or below, or both, indicate the occurrence of a dry winter. During drought episodes, Hawaii was located under an area of strong subsidence, and synoptic systems that normally produce winter and spring rainfall in the Hawaiian Islands were retarded. An anomalously cold sea-surface temperature in the north-central Pacific may also further enhance and prolong the dryness by reducing the rate of evaporation from the sea surface and by stabilizing the overlying air. Individual forecasts carried out for recent years reveal that severe drought during an El Nino/Southern Oscillation (ENSO) winter could be predicted two seasons in advance using simple regression models. For the non-ENSO drought winter, forecasting ability degrades somewhat. Overall, by means of a cross-validation technique, antecedent conditions of the large-scale pressure see-saw are useful predictors for Hawaiian winter rainfall anomalies, particularly when an ENSO-like phenomenon has started to develop. (Author's abstract) W90-04998

FEEDBACK MECHANISM IN ANNUAL RAINFALL, CENTRAL SUDAN.

Khartoum Univ. (Sudan). Dept. of Civil Engineering.

E. A. B. Eltahir.

Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 323-334, October 1989. 4 fig, 1 tab, 8 ref, append.

Descriptors: *Hydrologic budget, *Evaporation, *Meteorology, *Climatology, *Sudan, *Rainfall, Mathematical models, Mathematical studies, Rain gages.

The hypothesis that the annual rainfall process in Central Sudan is dependent on a feedback mechanism is investigated using a mathematical model based on the water balance of the neighboring region, Bahr Elghazal. All the precipitation in the Bahr Elghazal basin evaporates, either in the same year or in the following years, and contributes to precipitation in Central Sudan. A high level of rainfall in Bahr Elghazal in any year results in increased evaporation in the following years and, hence, higher levels of rainfall in those years in Central Sudan. The annual rainfall series in Bahr Elghazal is similar to the annual rainfall series in Central Sudan. Hence high levels of rainfall in the entire region in any year will probably result in high levels of rainfall in Central Sudan in the following years and vice versa. The mathematical model represented the water balance of the atmospheric system above the Bahr Elghazal basin, the atmospheric system above Central Sudan and the water balance of the Bahr Elghazal basin based on the conservation of mass. The dependence is weak which makes it difficult to trace the causative physical mechanisms. More accurate measurements of the regional rainfall amounts are needed to support the validity of the hypothesis. However, any project which plans to introduce changes in the hydrology of the Bahr Elghazal basin by reducing the evaporation losses should investigate the possible reduction in the rainfall amounts in Central Sudan. (Geiger-PTT) W90-05005

SNOWFALL INTO A FOREST AND CLEARING.

Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

For primary bibliographic entry see Field 2C.

W90-05006

HYDROMETEOROLOGICAL TIME SERIES SEGMENTATION - APPLICATION TO WEST

AFRICAN RAINFALL AND DISCHARGE SERIES (SEGMENTATION DES SERIES HYDROMETEOROLOGIQUES - APPLICATION A DES SERIES DE PRECIPITATIONS ET DE DEBITS DE L'AFRIQUE DE L'OUEST).

Ecole Nationale Supérieure des Mines de Paris, Fontainebleau (France). Centre d'Information Géologique.

P. Hubert, J. P. Carboneil, and A. Chaouche.

Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 349-367, October 1989. 4 fig, 1 tab, 38 ref. English summary.

Descriptors: *Rainfall-runoff relationships, *Rainfall, *Discharge hydrographs, *Africa, *Time series analysis, *Climatic data, Meteorological data collections, Data interpretation, Arid climates, Algorithms, Mathematical studies.

An original segmentation procedure of hydrometeorological series is detailed. From the beginning of this century, the results of rainfall and discharge series analysis exhibit a West African climatological evolution in successive stages. These stages, separated by jumps, come within more and more arid general tendency. The length of the sequences between the jumps are 9 to more than 19 years long. These climatological sequences, computed from various time series are concomitant and then have a regional significance. (Author's abstract) W90-05007

PUMPAGE, WATER LEVELS AND RAINFALL IN THREE WELLFIELDS IN WESTERN GALILEE, ISRAEL.

Ministry of Agriculture, Haifa (Israel). Hydrological Service.

For primary bibliographic entry see Field 2F.

W90-05008

NEW RADAR TECHNIQUE FOR SATELLITE RAINFALL ALGORITHM DEVELOPMENT.

Applied Research Corp., Landover, MD.

For primary bibliographic entry see Field 7B.

W90-05139

FREQUENCY DISTRIBUTION AND HYDROCLIMATIC CHARACTERISTICS OF HEAVY RAINSTORMS IN ILLINOIS.

Illinois State Water Survey Div., Champaign.

F. A. Huff, and J. R. Angel.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-133862. Price codes: A10 in paper copy, A01 in microfiche. State of Illinois Bulletin 70, 1988. 213p, 29 fig, 40 tab, 38 ref, 5 append.

Descriptors: *Meteorology, *Frequency distribution, *Climatology, *Rainstorms, *Illinois, Chicago, Seasonal variation, Spatial distribution, Temporal distribution, Floods, Urban areas, Urban hydrology, Rainfall intensity.

The most frequent type of rainstorm that produces flash floods in Illinois and the United States is very localized and produces extreme rainfall rates. Approximately 40 of these storms will occur in an average year in Illinois, or about one for every 1,500 sq mi of territory. These storms cause serious local flooding problems for farmers (crop damage) and urban areas, and interfere with small reservoir operations. However, other flood-producing storms, affecting relatively large areas ranging from the size of a county to 20,000 or more square miles, result from a series of moderately intense showers and thunderstorms that occur intermittently for periods of one to 10 days. This can result in both localized and widespread flooding. The study utilized data for an 83-year period (1901-83) collected at 61 Illinois stations in addition to data from nearby stations in surrounding states. The following topics are discussed: (1) the methods, analysis, and results of the study of potential climatic trends or fluctuations in the distribution of heavy rainstorms in Illinois; (2) the frequency distribution of heavy rainfall events is derived and findings; (3) information on urban effects on the frequency distribution of heavy rainstorms, with particular emphasis on the Chicago region; (4)

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analytical methods employed and results forthcoming from an investigation of the natural variability about average frequency relations in 10 sections of approximately homogeneous rainstorm climate; (5) seasonal frequency distributions of heavy rain events in Illinois for the four seasons and the causes of substantial regional differences in the distributions; (6) spatial and temporal characteristics of heavy storms not included in the study but that have been derived from other Illinois studies, and which are important to users of heavy rain-storm climatology in the design and operation of water control structures. (Lantz-PTT)
W90-05161

FINAL REPORT ON THE COOPERATIVE VAS PROGRAM WITH THE MARSHALL SPACE FLIGHT CENTER.

Wisconsin Univ.-Madison. Cooperative Inst. for Meteorological Satellite Studies.
For primary bibliographic entry see Field 7B.
W90-05168

FORMATION AND OPTICAL PROPERTIES OF A WARM CLOUD IN A SLOW-EXPANSION CLOUD CHAMBER.

City Coll., New York. Dept. of Earth and Planetary Sciences.
E. E. Hindman.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 2-4, p. 3653-3663, December 1989. 12 fig, 1 tab, 33 ref. ONR Contracts N00014-79-C-0793, N00014-87-K-0535, and N00014-89-J-1955; NSF Grants ATM 85-19370 and ATM 87-04776.

Descriptors: *Clouds, *Weather, *Cloud physics, Cloud chambers, Supersaturation, Air pollution, Droplets, Electromagnetic energy.

The formation of a warm cloud was studied in a 1.1 cu. m. isothermal, slow-expansion cloud chamber. The evolution of the precloud haze droplet population into the inclosed haze and cloud droplet populations was measured in unprecedented detail. The chamber environment was found to closely reproduce cloud formation in an adiabatically expanding parcel. Further, the microphysical characteristics of the cloud resembled those of a marine stratocumulus cloud. A procedure for estimating subsaturated and supersaturated relative humidity values was developed and shown to reproduce modeled values. Unique measurements of cloud droplets evaporating into haze droplets were obtained. It appeared that newly activated droplets, which had not grown too large, evaporated in supersaturated conditions when the supersaturation reduced below the equilibrium supersaturation value of the droplets. The visual range within the chamber was calculated to be 4 m, a value sufficiently low to conduct electromagnetic energy propagation experiments. (Author's abstract)
W90-05288

ESTIMATION OF RAINFALL FOR FLOOD FORECASTING USING RADAR AND RAIN GAGE DATA.

Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 7B.
W90-05589

2C. Snow, Ice, and Frost

INFLUENCE OF RIMING ON THE CHEMICAL COMPOSITION OF SNOW IN WINTER OROGRAPHIC STORMS.

Nevada Univ. System, Reno. Atmospheric Sciences Center.
D. L. Mitchell, and D. Lamb.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 94, No. 12, p. 14,831-14,840, October 20, 1989. 5 fig, 5 tab, 29 ref. NSF grant ATM-8520123.

Descriptors: *Water chemistry, *Rime, *Path of pollutants, *Orographic precipitation, *Storms, *Snow, *Chemistry of precipitation, *Ice, Path of pollutants, Cloud liquid water, Atmospheric water, Hydrodynamics, Clouds.

The chemical composition of surface snow and rime ice was measured in a winter mountain setting to identify the principal scavenging mechanisms. The siting permitted the results to be interpreted with minimal consideration of below-cloud scavenging processes and close comparison of the snow and rime ice compositions. The concentrations of all major ions in the snow were well below those in the rime ice and could be related to the estimated degree of snow crystal riming. The results of this study support the two-step concept of wet removal, in which atmospheric pollutants are first incorporated into cloud droplets and then removed from the cloud through the hydrodynamical collection of the droplets by falling precipitation elements. Under some meteorological conditions, therefore, it is likely that pollutant removal from the atmosphere is mechanistically limited by the removal of cloud water. (Author's abstract)
W90-04608

ADVANCE OF HUBBARD GLACIER AND 1986 OUTBURST OF RUSSELL FIORD, ALASKA, U.S.A.

Geological Survey, Fairbanks, AK.
L. R. Mayo.
Annals of Glaciology, Vol. 13, p. 189-194, 1989. 8 fig, 1 tab, 16 ref.

Descriptors: *Glaciers, *Glacier surges, *Fjords, *Alaska, Moraines, Glacial lakes, Flood damage, Icebergs.

Hubbard Glacier, the largest tide-water glacier in North America, has advanced since it was first mapped in 1895 by moving a protective submarine moraine into the entrance of Russell Fiord. In May 1986, a weak surge of the Valerie tributary of Hubbard Glacier caused the glacier to block the fiord entrance, converting the body of water into a large glacier-dammed lake. This lake filled to a height of 25.5 m and stored 5.4 cu km of water before it burst out on 8 October 1986, producing a peak flow of 105,000 cu m/s averaged for 1 h. Hubbard Glacier is expected to continue advancing because its accumulation area ratio is 0.95, which is unusually large. Such an advance would undoubtedly block Russell Fiord again. If this happens, it is predicted that the lake will fill to a height of 39 m over a period of 1.1-1.5 years and then overflow into the Situk River near Yakutat. This, in turn, would increase the average flow of that small stream from its present rate of, between 10 and 15 m/s to an estimated annual average discharge of 230 m/s. Such an increase in flow would be expected to flood and erode forest lands, fish habitats, subsistence fishing camps, archaeological sites, and roads. At the same time, the increased water depth in Russell Fiord could be expected to increase the calving rate of Hubbard Glacier, potentially threatening the stability of its calving terminus. (Author's abstract)
W90-04708

ORGANIC CARBON TRANSPORT IN AN UNDISTURBED BOREAL HUMIC RIVER IN NORTHERN FINLAND.

National Board of Waters, Oulu (Finland). District Office.
For primary bibliographic entry see Field 2H.
W90-04804

SNOWFALL INTO A FOREST AND CLEARING.

Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
R. A. Schmidt, and C. A. Troendle.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p. 335-348, October 1989. 8 fig, 2 tab, 17 ref.

Descriptors: *Meteorology, *Snow density, *Canopy, *Throughfall, *Interception, Wind, Air circulation, Coniferous forests, Clear-cutting, Snow accumulation.

Experiments in February-March 1987 at Fraser experimental Forest in Colorado, compared the number flux of snow particles above the center of an 80-m wide clearing with simultaneous samples in and above the forest 85 m upwind. Numbers of

snow particles counted with electronic sensors on towers decreased with decreasing height below the canopy top in the forest and also nearer the surface in the clearing. Average fluxes were greater in the clearing than in the forest, and these differences increased with increasing average wind speed, in the 0-6 m/sec range, measured during the experiments. The greater flux at the tower in the clearing could not be completely explained by interception of snow in the forest canopy, indicating that aerodynamics may have played a part in creating the difference, even in those light winds. A plume or concentration of snow particles appeared to have developed near the top of the canopy and spread into the clearing. (Author's abstract)
W90-05006

SUBMERSED MACROPHYTE COMMUNITIES BEFORE AND AFTER AN EPISODIC ICE JAM IN THE ST. CLAIR AND DETROIT RIVERS.

National Fisheries Research Center-Great Lakes, Ann Arbor, MI.
S. J. Nichols, D. W. Schloesser, and P. L. Hudson.
Canadian Journal of Botany CJBOW, Vol. 67, No. 8, p. 2364-2370, August 1989. 3 fig, 5 tab, 15 ref.

Descriptors: *Ice jams, *Macrophytes, *Ice cover, Aquatic productivity, Biomass, Submerged plants, Aquatic plants, St Clair River, Detroit River.

In 1983 and 1984, surveys of submersed macrophyte communities off six islands in the St. Clair and Detroit rivers using low aerial photography and ground-truth collections were conducted. Sample collections in 1984 followed one of the coldest winters on record, during which ice up to 4 m thick developed in areas that were normally ice free. Growth of many of the 20 taxa collected was delayed in the spring of 1984, as compared with the spring of 1983. By September 1984, however, total abundance of all taxa was equal to or greater than that in 1983. It was concluded that the unusual ice jam in early spring of 1984 had little, if any, permanent effect on submersed macrophytes in the St. Clair and Detroit rivers. (Author's abstract)
W90-05353

MASS MOVEMENT OF RIVER ICE CAUSES SEVERE TREE WOUNDS ALONG THE GRANDE RONDE RIVER IN NORTHEASTERN OREGON.

Forest Service, La Grande, OR. Forestry and Range Sciences Lab.
G. M. Filip, L. D. Bryant, and C. A. Parks.
Northwest Science NOSCA, Vol. 9, No. 5, p. 211-213, November 1989. 2 fig, 4 ref.

Descriptors: *Ice drift, *Ice breakup, *Riparian vegetation, Trees, Conifers, Shrubs, Oregon, Washington, Environmental effects, Thawing, Deciduous trees.

In eastern Oregon and Washington, ice forms in streams and rivers during prolonged periods of freezing temperatures. When rapid thawing occurs, large pieces of ice detach, move down waterways, strike trees, and cause damage. Tree wounds caused by ice movement were categorized on black cottonwood (*Populus trichocarpa* Torr. and Gray), willows (*salix* spp.), ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco). Tree wounds ranged from 63 to 14,066 sq cm which resulted in 3 to 100 percent bark removal at about 1.4 m above the ground. Wounded conifers did not have appreciable decay. Ice movement caused either mortality of important shrub species, such as mountain alder (*Alnus incana* (L.) Moench), or indirect mortality through wounding and subsequent infection by canker fungi. This indicates that such damage may seriously affect these riparian zones and thus affect the many associated resources. (Author's abstract)
W90-05381

Field 2—WATER CYCLE

Group 2D—Evaporation and Transpiration

2D. Evaporation and Transpiration

ACCURACY OF ESTIMATED REFERENCE CROP EVAPOTRANSPIRATION.

Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
G. H. Hargreaves.

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 1000-1007, December 1989. 3 tab, 12 ref.

Descriptors: *Grasses, *Evapotranspiration, *Climatology, Crops, Irrigation requirements, Air temperature, Relative humidity, Solar radiation, California, Performance evaluation.

Evapotranspiration from cool-season grasses is used as the reference for ET₀ (reference crop evapotranspiration). The requirements for local calibration for three equations for ET₀ recommended by the Food and Agriculture Organization of the United Nations (FAO) are shown for different climatic regions of California. Data from measured cool-season-grass evapotranspiration and Class A pan evaporation from sites located in large well-watered, irrigated grass pastures in three distinct climatic conditions are used to evaluate a method for estimating ET₀ that requires only measured values of maximum and minimum air temperatures. Mean temperature, minimum relative humidity, and solar radiation can all be estimated from maximum and minimum air temperatures. The equation for ET₀ that requires only temperature measurements may seem to be quite simple, but it is in reality a very comprehensive procedure incorporating most of the climatic interactions that influence the evaporative potential. The analysis of data from four lysimeters and Class A pan sites in California indicates that the temperature-range equation estimates ET₀ reasonably well in a large variety of climates. The corrected Penman and other equations recommended by FAO are shown to usually overestimate ET₀ in various climatic regions of California. (Author's abstract)
W90-04820

EVAPOTRANSPIRATION IN SUDAN GEZIRA IRRIGATION SCHEME.

Hydraulics Research Station, Wad Medani (Sudan).

A. S. A. Hussein, and A. K. El Daw.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 1018-1033, December 1989. 8 fig, 3 tab, 26 ref.

Descriptors: *Irrigation programs, *Sudan, *Irrigation, *Evapotranspiration, Crops, Grasses, Cotton, Wheat, Nuts.

Rapid irrigation development in the Sudan has stretched to the limit its share in the Nile waters. Significant savings on irrigation water can be made by improved water management. Accurate estimation of crops evapotranspiration, ET, is a prerequisite. ET was estimated by predicting first reference crop evapotranspiration. Grass was selected as the reference crop. FAO-Penman with Penman wind function for clipped grass was ranked first among the methods selected to predict grass ET. Using the crop coefficients of Doorenbos and Kassam, ET for cotton, groundnuts and wheat grown in the Gezira scheme were then predicted. Predicted and measured ET remained well within $\pm 15\%$. For air temperature higher and lower than 28.3 C, it was found that warm-season grass ET was equal to 1.0 and 0.635 ET of cool-season grass, respectively. Because of this temperature effect, care must be taken not to use these two grass varieties indiscriminately to estimate crop ET. (Author's abstract)
W90-04822

2E. Streamflow and Runoff

GEOMORPHIC RESPONSE OF COASTAL STREAMS TO LOW, INTERMEDIATE, AND HIGH RATES OF UPLIFT, MENDOCINO

TRIPLE JUNCTION REGION, NORTHERN CALIFORNIA.

Franklin and Marshall Coll., Lancaster, PA. Dept. of Geology.

D. Meritts, and K. R. Vincent.
Geological Society of America Bulletin BULMAF, Vol. 101, No. 11, p 1373-1388, November 1989. 11 fig, 3 tab, 47 ref.

Descriptors: *California, *Geomorphology, *Channel morphology, *Basins, *Coastal streams, *Tectonics, Catchment areas, Stream upflow, Stream gradient.

Analysis of three-dimensional morphological properties of 24 coastal drainage basins that have evolved in areas of low ($< 1 \text{ m/1,000 yr}$), intermediate ($1-3 \text{ m/1,000 yr}$), and high ($> 3 \text{ m/1,000 yr}$) rates of uplift near the Mendocino triple junction (MTJ), coastal northern California, identified channel gradients as the best indicator of tectonism in the landscape. Lower-order tributaries best reflect tectonically controlled differences. The largest streams examined, of third order, are able to adjust to most base-level change and maintain their profile form, whereas lower-order streams farther upstream tend to accumulate the effects of net base-level fall and have steepest profiles in the areas of highest uplift rates. Variations in steepness of first-order channel gradients indicate that (1) high uplift rates in the wake of the MTJ have existed for at least 73,000 yr and (2) differential tilt of the region to the north and south of the current locus of highest uplift rate is occurring in association with regional uplift. Although first-order streams are excellent indicators of areas of both high uplift rates and regional differential tilting, they are less useful in distinguishing between areas of low and intermediate uplift rate. Analysis of the longitudinal profile of the main trunk stream of ten of the 24 drainage basins, using the stream-gradient index, was more useful to categorize broadly the uplift rates and to distinguish between streams in low-uplift and intermediate-uplift rate areas. Although the hypotheses tested do not identify the exact mechanism of uplift in the MTJ region, they do indicate that the nature of deformation is most likely regional tilt rather than crustal shortening with localized compressional folding and thrust faulting. They also indicate that geomorphic responses trail in the wake of the uplift-rate response caused by development of a slab window beneath the North American plate: (1) maximum uplift rates occur about 9 km south of the northern boundary of the slab window, (2) maximum mean first-order channel gradient occurs 16 km south of the northern edge of the slab window, and (3) maximum drainage-basin relief occurs 20 km south of the northern edge of the slab window. (Author's abstract)
W90-04584

HYDROLOGY OF SMALL TRIBUTARY STREAMS IN A SUBARCTIC WETLAND.

McMaster Univ., Hamilton (Ontario). Dept. of Geography.

M. K. Woo, and P. D. diCenzo.
Canadian Journal of Earth Sciences CJESAP, Vol. 26, No. 8, p 1557-1566, 1989. 11 fig, 2 tab, 21 ref.

Descriptors: *Subarctic zone, *Catchment areas, *Tributaries, *Runoff, *Wetlands, *Overland flow, Flood plains, Rainfall-runoff relationships, Snowmelt, Saturated flow.

Rivers traversing subarctic wetlands are fed by numerous small tributary creeks, which carry much of the wetland runoff into the rivers during the snow-free season. The wetlands, being saturated, generate abundant surface flow in the spring melt season. This amount of water cannot be accommodated by the tributary creeks and, together with general flooding of the rivers, there is little distinction between overland flow and channelled flow across the wetland, the feeder tributaries, and the major rivers. After snowmelt, the water level subsides, and most of the overland flow from the wetland is funnelled into the feeder creeks. The feeders can usually respond quickly to rainstorms and recessions are short unless surface flow is sustained by extensive marshy depressions. Along the lower reaches of the major rivers, the small

tributary creeks are the main conveyors of wetland runoff to the rivers and therefore strongly modify the runoff characteristics of the rivers. (Author's abstract)
W90-04587

ECOLOGY OF A WADI IN IRAQ WITH PARTICULAR REFERENCE TO COLONIZATION STRATEGIES OF AQUATIC MACROINVERTEBRATES.

Zoologische Staatssammlung Muenchen (Germany, F.R.).

For primary bibliographic entry see Field 2H.
W90-04632

SOIL NITROGEN CHANGES DURING PRIMARY SUCCESSION ON A FLOODPLAIN IN ALASKA, U.S.A.

Alaska Univ., Fairbanks. Arctic Environmental Engineering Lab.

For primary bibliographic entry see Field 2G.
W90-04639

STREAM DEVELOPMENT IN GLACIER BAY NATIONAL PARK, ALASKA, U.S.A.

Forest Service, Logan, UT. Intermountain Research Station.

For primary bibliographic entry see Field 2J.
W90-04640

ORGANIC CARBON ISOTOPE RATIOS AND IMPLICATIONS FOR THE MAXIMUM TURBIDITY ZONE OF THE ST. LAWRENCE ESTUARY.

Quebec Univ., Montreal.

For primary bibliographic entry see Field 2L.
W90-04641

RUNOFF AND FLOCCULATION MODIFY UNDERWATER LIGHT ENVIRONMENT OF THE HUDSON RIVER ESTUARY.

State Univ. of New York at Albany. Dept. of Biological Sciences.

For primary bibliographic entry see Field 2L.
W90-04642

ANALYTIC TECHNIQUE FOR STOCHASTIC ANALYSIS IN ENVIRONMENTAL MODELS.

Alaska Univ., Fairbanks. Dept. of Civil Engineering.

M. A. Tumeo, and G. T. Orlob.
Water Resources Research WRRERQ, Vol. 25, No. 12, p 2417-2422, December 1989. 1 fig, 2 tab, 20 ref.

Descriptors: *Model studies, *Stochastic models, *Mathematical analysis, *Rivers, *Biochemical oxygen demand, *Oxygen deficit, Sacramento River, California, Monte Carlo method.

The development and application of a new mathematical technique to include stochasticity in environmental models is presented. The technique, named the probability density function/moment technique (PDF/M), is based on a two-tiered process. First, the basic governing equations are expanded to include stochastic terms. Stochastic terms are separated from nonfluctuating terms, and the resulting set of equations is solved simultaneously. Solutions are used to calculate the moments of the output variables. Second, the moments are used in conjunction with the Fokker-Planck equation to produce an analytical solution for the probability density functions of the dependent variables. Because the approach produces analytical solutions, it offers greater flexibility than a Monte Carlo approach in treating complex environmental situations. Unlike the stochastic differential equation approach, it is not necessary to assume Gaussian distributions in the solution technique; complex random fluctuations of time and space may be included, and solutions are possible for higher-dimensional problems and cases with stochastic variations in stream velocity. The PDF/M technique represents a new and potentially powerful tool for extending the capabilities of computer

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er models in management and decision analysis by providing analytical solutions for the probability density functions and associated moments of important environmental variables. The model was applied to a study of biochemical oxygen demand and oxygen deficit values along a stretch of the Sacramento River, and compared favorably in estimating statistics of field surveys. (Author's abstract)
W90-04659

COMPARISON OF ON-SITE AND LABORATORY TOXICITY TESTS: DERIVATION OF SITE-SPECIFIC CRITERIA FOR UN-IONIZED AMMONIA IN A COLORADO TRANSITION-AL STREAM.

Environmental Protection Agency, Denver, CO. Region VIII.
For primary bibliographic entry see Field 5C.
W90-04695

SIMPLE AND PRACTICAL MODEL FOR TOXICOLOGICAL ASSESSMENT OF NITRIFICATION BYPRODUCTS IN RIVERS.

Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.
For primary bibliographic entry see Field 5B.
W90-04702

NUTRIENT AND WATER FLUX IN A SMALL ARCTIC WATERSHED: AN OVERVIEW.

San Diego State Univ., CA. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-04712

HYDROLOGY OF IMNAVAIT CREEK, AN ARCTIC WATERSHED.

Alaska Univ., Fairbanks. Water Research Center. D. L. Kane, L. D. Hinzman, C. S. Benson, and K. R. Everett.
Holartic Ecology HOECD2, Vol. 12, No. 3, p 262-269, Oct 1989. 6 fig, 3 tab, 14 ref.

Descriptors: *Small watersheds, *Streams, *Hydrology, *Arctic zone, *Ecosystems, Headwaters, Hydrologic cycle, Seasonal variation.

An ecological study is presently being carried out at the headwaters of Imnavait Creek to develop a better understanding of the dynamics of an arctic ecosystem. While all ecosystems are driven by both energy and mass inputs, in an arctic setting this is much more evident. Therefore it is critical that we have a detailed understanding of the hydrology of the basin. In the United States, no hydrological studies of an arctic watershed have been made where measurements are continued throughout the winter season. While most biological processes are dormant throughout the winter, this is not true of physical processes such as active layer freezing and thawing and snow accumulation and redistribution by wind. This paper summarizes what we have learned hydrologically from three years of study at an arctic watershed, Imnavait Creek. (Author's abstract)
W90-04713

SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF AN ARCTIC BEADED STREAM.

Alaska Univ., Fairbanks. Inst. of Arctic Biology. M. W. Oswood, K. R. Everett, and D. M. Schell.
Holartic Ecology HOECD2, Vol. 12, No. 3, p 290-295, Oct 1989. 6 fig, 1 tab, 23 ref.

Descriptors: *Ponded streams, *Arctic zone, *Water chemistry, *Channel morphology, *Beaded streams, Tundra, Physical properties, Chemical properties, Hydrologic properties, Dissolved solids, Alaska.

Imnavait Creek is a tundra stream in the Arctic Foothills of Alaska. The stream is beaded, i.e. consists of pools (up to about 2 m deep) connected by narrow channels. Peat dominates pool and channel substrate materials with occasional rock and moss substrates. The watershed is underlain by

ice-bonded till and is hydrologically watertight. Because of low rates of weathering, bedrock and till do not contribute significantly to ionic composition of the stream water. Breakup occurs in late May to early June with surface flow until September. During periods of low rainfall, channel flow is reduced and pools become hydrologically isolated and thermally stratified (with very high surface water temperatures). Streamwater is acidic (pH values 5.3-6.1) with very low alkalinity (up to 3 mg/L). The major transport of ions occurs in early flow derived from snow melt. Organic carbon concentrations are high with very high ratios of dissolved to particulate organic carbon. Dissolved inorganic nitrogen concentrations appear to be very low. High concentrations of dissolved organic material may indicate that it has a central role in trophic dynamics. (Author's abstract)
W90-04716

STANDING BIOMASS AND PRODUCTION IN WATER DRAINAGES OF THE FOOTHILLS OF THE PHILIP SMITH MOUNTAINS, ALASKA.

San Diego State Univ., CA. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-04717

COMPARATIVE EFFECTS OF DOWNSLOPE WATER AND NUTRIENT MOVEMENT ON PLANT NUTRITION, PHOTOSYNTHESIS, AND GROWTH IN ALASKAN TUNDRA.

Florida International Univ., Miami. Dept. of Biological Sciences.
S. F. Oberbauer, S. J. Hastings, J. L. Beyers, and W. E. Oechel.
Holartic Ecology HOECD2, Vol. 12, No. 3, p 324-334, Oct 1989. 2 fig, 7 tab, 19 ref. DOE Contract No. DE-FG03-84ER60250.

Descriptors: *Runoff, *Limnology, *Environmental effects, *Solute transport, *Plant physiology, *Tundra, Fertilization, Irrigation, Nutrients, Alaska.

Changes in water and nutrient movement are common disturbances resulting from human activities in arctic regions. To assess the influence of water and nutrient movement on different plant growth forms, we added water and nitrogen/phosphorus/potassium (NPK) fertilizer along 10 to 20 m linear transects across small natural drainages on an Alaskan tundra slope. Water was added by continuous-flow emitters from a drip irrigation system at a rate of 450 L/m/d during the 1986 growing season and 110 L/m/d in the 1987 growing season. NPK in the form of Osmocote, a slow release fertilizer, was applied at 0.5 kg per linear meter in early and mid-season of the 1985 growing season. Tissue N and P contents, light-saturated photosynthetic rates, and aboveground biomass production were measured at peak season for key species 2 m above and 2 and 6 m below the water and nutrient applications in 1986 and 1987. Mean leaf N and P of the species tested increased slightly 2 m below the water addition sites and dramatically below the fertilizer addition sites. Increases in tissue N and P were also found 6 m below the fertilizer addition points. Leaf photosynthesis tended to increase 2 m below the water and nutrient additions for the species tested. Six meters below the treatment application points, photosynthesis was minimally affected in 1986 but increased in 1987. Increases in leaf area on the irrigation treatments were found only for the evergreen species, *Ledum palustre* and *Vaccinium vitis-idaea*, 2 m below the site of addition. In contrast, fertilizer addition caused large increases in leaf area production for all species tested at 2 m below the treatment, and for some species at 6 m below treatment. The overall effects of the two treatments were similar, but were greater for the fertilizer addition. (Author's abstract)
W90-04719

FACTORS INFLUENCING SALMONID POPULATIONS IN SIX HEADWATERS STREAMS, CENTRAL ARIZONA, USA.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.

For primary bibliographic entry see Field 2H.
W90-04729

SIGNIFICANCE OF TEMPERATURE AND FOOD AS FACTORS AFFECTING THE GROWTH OF BROWN TROUT, *Salmo trutta* L., IN FOUR DANISH STREAMS.

Miljøstyrelsen, Silkeborg (Denmark). Freshwater Lab.

For primary bibliographic entry see Field 2H.
W90-04730

FISH PRODUCTION-BENTHOS PRODUCTION RELATIONSHIPS IN TROUT STREAMS.

Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W90-04731

SURVEYING THE ENTIRE RIVER ECOSYSTEM.

Anglian Water Authority, Lincoln (England). Lincoln Div.
For primary bibliographic entry see Field 2H.
W90-04732

PROCESSING OF STORM-WATER RUNOFF-FRENCH EXPERIMENTS.

Ministere de l'Equipeement, Paris (France). Services Techniques de l'Urbanisme.
For primary bibliographic entry see Field 5D.
W90-04770

ORGANIC CARBON TRANSPORT IN AN UNDISTURBED BOREAL HUMIC RIVER IN NORTHERN FINLAND.

National Board of Waters, Oulu (Finland). District Office.
For primary bibliographic entry see Field 2H.
W90-04804

DISSOLVED ORGANIC CARBON DYNAMICS OF DEVELOPED AND UNDEVELOPED WETLAND CATCHMENTS IN WESTLAND, NEW ZEALAND.

Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-04805

PRE-IMPOUNDMENT STUDIES OF THE FISHES OF OWA STREAM SOUTH-WEST, NIGERIA.

Ogun State Univ., Ago-Iwoye (Nigeria). Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-04810

RIVER QUALITY MODELING: FREQUENCY DOMAIN APPROACH.

California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W90-04821

INVERTED V-NOTCH: PRACTICAL PROPORTIONAL WEIR.

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-04823

EFFECT OF A CAVE ON BENTHIC INVERTEBRATE COMMUNITIES IN A SOUTH ISLAND STREAM.

Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-04874

Field 2—WATER CYCLE

Group 2E—Streamflow and Runoff

BREAKDOWN OF FOUR LEAF LITTER SPECIES AND ASSOCIATED FAUNA IN A BASQUE COUNTRY FORESTED STREAM.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecología.
For primary bibliographic entry see Field 2H.
W90-04884

SUMMER BACTERIAL POPULATIONS IN MISSISSIPPI RIVER POOL 19: IMPLICATIONS FOR SECONDARY PRODUCTION.
Illinois Natural History Survey, Champaign. Aquatic Biology Station.
For primary bibliographic entry see Field 2H.
W90-04885

SEASONAL DYNAMICS OF BENTHIC MACROINVERTEBRATE COMMUNITIES IN THE LOWER ARDECHE RIVER (FRANCE).
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 2H.
W90-04888

SEASONALITY IN RIVER PHYTOPLANKTON: MULTIVARIATE ANALYSES OF DATA FROM THE OHIO RIVER AND SIX KENTUCKY TRIBUTARIES.
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-04890

EFFECT OF LEAF PACK COMPOSITION ON PROCESSING: A COMPARISON OF MIXED AND SINGLE SPECIES PACKS.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 2H.
W90-04896

RIVER-CHANNEL CHANGES IN ENGLAND AND WALES.
Portsmouth Polytechnic (England). Dept. of Geography.
J. M. Hooke, and C. E. Redmond.
Journal of the Institution of Water Engineers and Scientists JIWSI, Vol. 3, No. 4, p 328-335, August 1989. 3 fig, 1 tab, 40 ref.

Descriptors: *English, *Wales, *Channel morphology, *Geomorphology, *Paleohydrology, *River flow, *River systems, Channel erosion, Channel improvement, History.

An investigation of the literature on river-channel changes in the UK reveals that the rate and extent of changes is much higher than was previously thought. In order to assess how widespread these changes are, and whether the rates and types of changes are typical, an historical survey has been carried out of the streams which drain the upland areas of England and Wales. This survey involved the comparison of Ordnance Survey 1:10,560 maps from approximately 1870 and 1950, and revealed that almost 35% of the rivers draining upland England have shown some pattern instability during this period. Great variety exists both in the types of channel planform changes and their extent: several rivers possess short isolated reaches of change separated by stable sections. This suggests the operation of thresholds of channel stability, and further research aims to identify these in terms of specific factors and conditions. (Author's abstract)
W90-04903

WHITE CART WATER FLOOD ALLEVIATION STUDY USING HYDRODYNAMIC MATHEMATICAL-MODELLING TECHNIQUES.
D. J. Banks, and R. H. Falconer.
Journal of the Institution of Water Engineers and Scientists JIWSI, Vol. 3, No. 4, p 375-386, August 1989. 5 fig, 4 tab, 3 ref.

Descriptors: *Model studies, *Floods, *Flood control, *Hydrodynamics, *Mathematical models, Model testing, Calibrations, Regional planning, Scotland.

This paper describes a hydrodynamic mathematical-modeling study to investigate the flooding problem and to recommend various flood-alleviation measures for the White Cart Water on the southern side of Glasgow. The mathematical model covers 36 kilometers of the White Cart to the tidal reaches at the confluence with the River Clyde, and includes 7 kilometers of one of the major tributaries where regular flooding is also a problem. A key aspect of the study was the close proximity of the modeling team which permitted a close scrutiny of the river during high-flow events. From these observations the team obtained a thorough appreciation of river behavior during potential flood situations, which provided a reliable and comprehensive set of data for model calibration over a wide range of conditions. The proposals for flood alleviation have far-reaching implications and require major capital expenditure. At present they are being examined by Strathclyde Regional Council in consultation with the many interested parties. (Author's abstract)
W90-04909

EXTREME HISTORICAL UK FLOODS AND MAXIMUM FLOOD ESTIMATION.
Institute of Hydrology, Wallingford (England). M. C. Acreman.
Journal of the Institution of Water Engineers and Scientists JIWSI, Vol. 3, No. 4, p 404-412, August 1989. 2 fig, 3 tab, 44 ref.

Descriptors: *Historic floods, *Maximum probable floods, *Flood forecasting, *Floods, *United Kingdom, Flood peak, Stream gages, Hydrology, Graphical methods, Design floods, History, Estimating.

Historical flood events recorded as flood marks on bridges and houses or reported in newspapers and journals provide valuable information on the maximum size of floods which are likely to occur in the United Kingdom. For hydrological analysis peak water level must be converted to peak discharge, which is problematic even when the flood has been recorded at a flow gaging station. Some of the methods used to calculate the magnitude of extreme floods are described. Sixty-nine historical United Kingdom floods are plotted on a graph of discharge versus drainage area and compared with curves published in 1933 and 1960 which were used to estimate the Normal Maximum Flood required for dam spillway design before 1975. From that date the design standard became the Probable Maximum Flood (PMF). PMF is calculated for 17 sites where extreme floods have occurred. For six events the observed peak discharge exceeded PMF. (Author's abstract)
W90-04912

WINTER ABUNDANCE OF CHANNEL CATFISH IN THE CHANNELIZED MISSOURI RIVER, NEBRASKA.
Nebraska Game and Parks Commission, Lincoln.
For primary bibliographic entry see Field 2H.
W90-04916

REQUIREMENT FOR A MICROBIAL CONSORTIUM TO COMPLETELY OXIDIZE GLUCOSE IN FE(III)-REDUCING SEDIMENTS.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W90-04936

CHANGES IN CONCENTRATION OF LEAD AND CADMIUM IN WATER FROM THREE RIVERS IN DERBYSHIRE.
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
For primary bibliographic entry see Field 5B.
W90-04943

BIOMASS AND OXYGEN DYNAMICS OF THE EPIPHYTE COMMUNITY IN A DANISH LOWLAND STREAM.
Copenhagen Univ., Hillerød (Denmark). Det Ferskvands-Biologiske Lab.

For primary bibliographic entry see Field 2H.
W90-04951

PERIPHYTON RESPONSES TO INVERTEBRATE GRAZING AND RIPARIAN CANOPY IN THREE NORTHERN CALIFORNIA COASTAL STREAMS.
California Univ., Berkeley. Dept. of Entomological Sciences.
For primary bibliographic entry see Field 2H.
W90-04952

ROTIFER OCCURRENCE IN RELATION TO WATER COLOUR.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 2H.
W90-04957

COMBINED EFFECTS OF CHLORINE AND AMMONIA ON LITTER BREAKDOWN IN OUTDOOR EXPERIMENTAL STREAMS.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 5C.
W90-04959

ECOLOGY OF THE LAMBRO RIVER.
Milan Univ. (Italy). Ist. di Biologia.
For primary bibliographic entry see Field 2H.
W90-04969

BACTERIAL PRODUCTION IN THE RHONE RIVER PLUME: EFFECT OF MIXING ON RELATIONSHIPS AMONG MICROBIAL ASSEMBLAGES.
Delaware Univ., Lewes. Coll. of Marine Studies.
For primary bibliographic entry see Field 2L.
W90-04979

BACKWATER LENGTHS IN RIVERS.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 8B.
W90-04990

HAWAIIAN DROUGHT AND THE SOUTHERN OSCILLATION.
Hawaii Univ., Honolulu. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W90-04998

GRAPHICAL ESTIMATION OF EXTREME VALUE PREDICTION FUNCTIONS.
Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences.
W. E. Bardsley.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 315-321, October 1989. 1 fig, 14 ref, append.

Descriptors: *Graphical analysis, *Flooding, *Mathematical studies, *Probability distribution, Mathematical models, Graphical methods, Prediction, Flood forecasting.

Graphical application of the Type 1 (Gumbel) extreme value distribution for flood analysis is very simple since the distribution inverse gives a linear x-y plot. In contrast, the Type 2 and Type 3 extreme value distributions have nonlinear functions with respect to the same axes. A simple three-point graphical estimation procedure is described for these two distributions. This approach allows the nonlinear flood magnitude prediction functions to be located in any desirable position relative to the plotted annual maxima, subject to the constraint of having an extreme value form. The computation is very simple and requires only the location of a unique zero of a one-parameter function within a defined interval. The three-point graphical estimation procedure was applied to the flow maxima of the Changjiang (Yangtze), using a data set of recent and historical floods. (Author's abstract)
W90-05004

Streamflow and Runoff—Group 2E

HYDROMETEOROLOGICAL TIME SERIES SEGMENTATION - APPLICATION TO WEST AFRICAN RAINFALL AND DISCHARGE SERIES (SEGMENTATION DES SERIES HYDROMETEOROLOGIQUES - APPLICATION A DES SERIES DE PRECIPITATIONS ET DE DEBITS DE L'AFRIQUE DE L'OUEST).

Ecole Nationale Supérieure des Mines de Paris, Fontainebleau (France). Centre d'Information Géologique.

For primary bibliographic entry see Field 2B.
W90-05007

CONTAMINATION OF GROUNDWATERS FROM DIFFUSE SOURCES ARISING FROM FARMING ACTIVITIES.

Southern Water Authority, Worthing (England).
For primary bibliographic entry see Field 5B.
W90-05019

LONGITUDINAL STUDY OF ZOOPLANKTON ALONG THE LOWER ORINOCO RIVER AND ITS DELTA (VENEZUELA).

Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana.

E. Vasquez, and J. Rey.
Annales de Limnologie ANLIB3, Vol. 25, No. 2, p. 107-120, 1989. 6 fig, 6 tab, 41 ref.

Descriptors: *Zooplankton, *Venezuela, *Rotifers, *Waterfleas, *Orinoco River, Density, Water level, Growth, Reproduction, Rivers, Deltas.

Zooplankton samples collected at low and high water in 14 and 21 stations respectively along some 900 km of the Orinoco and its Delta, revealed the presence of 100 rotifer and 48 cladoceran taxa. Of these, only 13 rotifer and 8 cladoceran species were frequent and numerically important, mainly *Keratella americana*, *Lecane proiecta*, *Ploesoma lenticulare*, *Polyarthra vulgaris*, *Bosmina tubicen*, *Bosminopsis deitersi*, *Diaphanosoma birgei* and *Moina minuta*. Nauplii were dominant among the copepods. At low water, rotifers were by far the most abundant group (mean 49 org/L) followed by cladocerans (mean 2.8 org/L) and copepods (1.5 org/L). At high water, rotifer densities declined to a mean of 3.5 org/L, followed by copepods (mean 3.4 org/L) and cladocerans (1.2 org/L). Mean zooplankton densities at low water were eight times higher than at high water. At low water, longitudinal zooplankton densities seemed to be influenced by tributary river waters. At high water, densities were generally low up to the Delta where a longitudinal increase was observed. A high proportion of egg carrying cladocerans, particularly *B. tubicen*, *B. deitersi* and *M. minuta*, was observed at low water along the sampling sites, suggesting an ability of the species for growth and reproduction in the river. (Author's abstract)
W90-05036

ORGANIC CARBON BUDGET IN A HEADWATER STREAM AT URATAKAO, (IN JAPAN).

Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Environmental Science and Conservation.

For primary bibliographic entry see Field 2H.
W90-05055

METHANOGENESIS IN SEDIMENTS OF THE POLLUTED LOWER REACHES OF THE TAMA RIVER.

Tokyo Metropolitan Univ. (Japan). Dept. of Biology.

For primary bibliographic entry see Field 5B.
W90-05056

INSTREAM CHEMICAL REACTIONS OF ACID MINE WATER ENTERING A NEUTRAL STREAM NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05067

METAL PARTITIONING AND PHOTOREDUCTION OF IRON IN FILTRATES OF ACID STREAMWATER, ST. KEVIN GULCH, LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05069

PARTITIONING OF METALS BETWEEN WATER AND FLOCCULATED BED MATERIAL IN A STREAM CONTAMINATED BY ACID MINE DRAINAGE NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05070

COLLOIDAL PROPERTIES OF FLOCCULATED BED MATERIAL IN A STREAM CONTAMINATED BY ACID MINE DRAINAGE, ST. KEVIN GULCH, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05071

HYDROXYL RADICAL FORMATION IN ST. KEVIN GULCH, AN IRON-RICH STREAM IN COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05073

OVERVIEW OF RESEARCH ACTIVITIES ON THE CHEYENNE RIVER SYSTEM, WESTERN SOUTH DAKOTA.

Geological Survey, Rapid City, SD.
For primary bibliographic entry see Field 5B.
W90-05082

ARSENIC IN THE ALLUVIAL SEDIMENTS OF WHITEWOOD CREEK AND THE BELLE FOURCHE AND CHEYENNE RIVERS IN WESTERN SOUTH DAKOTA.

Geological Survey, Rapid City, SD.
For primary bibliographic entry see Field 5B.
W90-05083

TRENDS IN ARSENIC CONCENTRATION AND GRAIN-SIZE DISTRIBUTION OF METAL-CONTAMINATED OVERBANK SEDIMENTS ALONG THE BELLE FOURCHE RIVER DOWNSTREAM FROM WHITEWOOD CREEK, SOUTH DAKOTA.

Geological Survey, Indianapolis, IN.
For primary bibliographic entry see Field 5B.
W90-05084

SOURCE AND TRANSPORT OF ARSENIC IN THE WHITEWOOD CREEK-BELLE FOURCHE-CHEYENNE RIVER-LAKE OAHIE SYSTEM, SOUTH DAKOTA.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05086

PERIPHYTON EFFECTS ON ARSENIC TRANSPORT IN WHITEWOOD CREEK, SOUTH DAKOTA.

Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-05088

FATE AND TRANSPORT OF ORGANIC COMPOUNDS AND TRACE ELEMENTS IN THE LOWER CALCASIEU RIVER, LOUISIANA.

Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W90-05090

REMOBILIZATION OF ORGANIC COMPOUNDS FROM BOTTOM MATERIAL COLLECTED FROM BAYOU D'INDE, LOUISIANA.

UPON EXPOSURE TO DIFFERING IONIC-STRENGTH WATERS.

Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W90-05091

PRELIMINARY RESULTS OF A STUDY OF THE CHEMISTRY OF GROUNDWATER AT THE BUILDING 24 RESEARCH SITE, PICA-TINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05098

PRELIMINARY ASSESSMENT OF THE FATE AND TRANSPORT OF SYNTHETIC ORGANIC AGROCHEMICALS IN THE LOWER MISSISSIPPI RIVER AND ITS TRIBUTARIES.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05109

SAMPLING, FRACTIONATION, AND DEWATERING OF SUSPENDED SEDIMENT FROM THE MISSISSIPPI RIVER FOR GEOCHEMICAL AND TRACE-CONTAMINANT ANALYSIS.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7B.
W90-05114

CHARACTERIZATION OF COLLOIDS IN THE MISSISSIPPI RIVER AND ITS MAJOR TRIBUTARIES.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2J.
W90-05115

RESEARCH ACTIVITIES RELATED TO ACIDIC WATER NEAR GLOBE, ARIZONA.

Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 5B.
W90-05125

EFFECTS OF FLY ASH AND FLUE-GAS DESULFURIZATION WASTES ON GROUNDWATER QUALITY IN A RECLAIMED LIGNITE STRIP MINE DISPOSAL SITE.

North Dakota Mining and Mineral Resources Research Inst., Grand Forks.
For primary bibliographic entry see Field 5B.
W90-05131

FLOOD INUNDATION MODELLING USING MILHY.

European Research Office, London (England).
M. G. Anderson, and L. Singleton.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A201 726.
Price codes: A04 in paper copy, A01 in microfiche.
Third Interim Report, September 1988. 56p, 35 fig, 4 tab, 3 ref. DOA Contract DAJA 45-87-C-0053.

Descriptors: *Flooding, *Mathematical models, *Flood hydrographs, *Flood forecasting, Model studies, Runoff, Hydrographs, Flood routing, Mathematical studies, Hydrodynamics, Precipitation, Hydraulic properties, Algorithms, Model testing.

The overall objective of this research project is to improve the accuracy of hydrograph prediction and to incorporate the capability of forecasting inundated areas in the MILHY2 model, while maintaining parsimonious data requirements. This is to be achieved by: (1) consideration of the impact of spatially distributed precipitation on the runoff hydrograph; (2) incorporation of appropriate hydraulic techniques which aim to improve the physical representation of out-of-bank conditions (including-turbulent exchange of flow between cross-sectional segments, introduction of multiple routing reach paths to allow discrete pathways for deep floodplain flows, and a comparative study of the performance of alternative flood routing tech-

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niques in the overbank environment); (3) development of a module based scheme where the operator may select either more detailed or simpler module algorithms based on operational rules guiding data requirement, computational demands and solution specifications; (4) validation of the methodology by either a study of the performance of individual modules using hydrographs and inundation maps on scales from 150 sq km to 2500 sq km, or comparison of the performance of the hydrologically based MILHY3 with the two-dimensional hydrodynamic finite element model RMA-2. (Lantz-PTT)
W90-05181

REVIEW OF THE U.S. ARMY CORPS OF ENGINEERS INVOLVEMENT WITH ALLUVIAL FAN FLOODING PROBLEMS.

Hydrologic Engineering Center, Davis, CA. R. C. MacArthur, and D. L. Hamilton. Available from the National Technical Information Service, Springfield, VA 22161, as AD-A202 119. Price codes: A03 in paper copy, A01 in microfiche. Technical Paper No. 124, December 1988. 16p, 5 fig, 29 ref.

Descriptors: *Alluvial fans, *Alluvial plains, *Flooding, *Flood plain management, Flood plains, Case studies, California, Flood protection, Utah, History, Public policy, Legal aspects.

The US Army Corps of Engineers has shared responsibility for resolving flood problems in the United States. Alluvial fans are areas of special interest that present some of the most complex analytical and managerial challenges to engineers and floodplain managers. There are many different analytical approaches used to assess flood hazards on alluvial fans. The present consensus among experienced engineers and geologists, however, is that there is no single, clearly superior method for accurate assessment of flood hazards on alluvial fans. Experience and good engineering judgement are the most important factors in the successful selection and application of any technique. This paper presents a general overview of the Corps of Engineers past involvements, present practices, and the future roles in dealing with alluvial fan flooding problems. Two selected case studies conducted by the Corps of Engineers are presented—alluvial fan flood protection studies in Coachella Valley, CA, and mudflow studies on the alluvial fans of Davis County, UT. While conducting projects dealing with alluvial fan flooding, the Corps has identified six important issues that need to be a part of an effective management approach: issues of historical perspective, issues of technical knowledge, issues of analytical ability, issues of institutional leadership, issues of public behavior, and issues of legal implications. (Lantz-PTT)
W90-05186

FLOOD OF SEPTEMBER 7-9, 1987, IN LEXINGTON AND RICHLAND COUNTIES IN THE VICINITY OF SAINT ANDREWS ROAD AND IRMO, SOUTH CAROLINA.

Geological Survey, Columbia, SC. Water Resources Div. W. B. Guimaraes. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4077, Nov. 1989. 37p, 2 plates, 18 fig, 5 tab, 12 ref.

Descriptors: *Floods, *Flood discharge, *Flood frequency, *Flood peak, *Flood recurrence interval, *South Carolina, Rainfall-runoff relationships.

Localized heavy rainfall on September 7, 1987, in Lexington and Richland Counties, South Carolina, caused severe flooding in the basins of Kinley Creek, Rawls Creek, and Stoop Creek, in the vicinity of Saint Andrews Road and the town of Irmo, South Carolina. The flooding damaged homes, furnishings and landscaping. Rainfall, peak discharges, high-water elevations, and frequency relations of rainfall and discharge are tabulated and plotted for selected streams. The rain was most intense in the area along Rawls Creek, R-2 (tributary to Rawls Creek), Koon Branch (tributary to Rawls Creek), and the upper part of Kinley Creek.

A rainfall of about 5.5 inches in 3 hours, which has a recurrence interval in excess of 100 years, was reported by local residents along these streams. High-water marks are presented in this report for Stoop Creek, Kinley Creek, K-1 (tributary to Kinley Creek), K-2 (tributary to Kinley Creek), unnamed tributary to Kinley Creek, Lowery Creek (tributary to Kinley Creek), Rawls Creek, R-2 (tributary to Rawls Creek), and Koon Branch (tributary to Rawls Creek). Peak discharges at the most downstream sites on Rawls Creek and Koon Branch had recurrence intervals of 75 years and 60 years, respectively. Peak discharges on Kinley Creek varied from 20 to 25 years north of K-1 basin to less than 10 years at K-1. The Stoop Creek basin had a recurrence interval of 10 years. (USGS)
W90-05188

HYDROLOGIC EVALUATION AND WATER SUPPLY CONSIDERATIONS FOR FIVE PAIUTE INDIAN LAND PARCELS, MILLARD, SEVIER, AND IRON COUNTIES, SOUTH-WESTERN UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div. For primary bibliographic entry see Field 2F.
W90-05189

ACCURACY OF ACOUSTIC VELOCITY METERING SYSTEMS FOR MEASUREMENT OF LOW VELOCITY IN OPEN CHANNELS.

Geological Survey, Tallahassee, FL. Water Resources Div. For primary bibliographic entry see Field 7B.
W90-05190

HYDRAULIC CHARACTERISTICS OF THE NEW RIVER IN THE NEW RIVER GORGE NATIONAL RIVER, WEST VIRGINIA.

Geological Survey, Charleston, WV. J. B. Wiley, and D. H. Appel. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-243, 1989. 34p, 25 fig, 1 tab, 6 ref.

Descriptors: *Streamflow, *Surface water, *Dye releases, *Dye dispersion, *Stage-discharge relations, *Water depth, *Water surface profiles, *Tracers, *West Virginia, New River, Wave propagation, Varied flow, Dyes.

Traveltime, dispersion, water-surface and streambed profiles, and cross-section data were collected for use in application of flow and solute-transport models to the New River in the New River Gorge National River, West Virginia. Dye clouds subjected to increasing and decreasing flow rates (unsteady flow) showed that increasing flows shorten the cloud and decreasing flows lengthen the cloud. After the flow rate was changed and the flow was again steady, traveltime and dispersion characteristics were determined by the new rate of flow. Seven stage/streamflow relations identified the general changes of stream geometry throughout the study reach. Channel cross sections were estimated for model input. Low water and streambed profiles were developed from surveyed water surface elevations and water depths. (USGS)
W90-05191

FLOOD BOUNDARIES AND WATER-SURFACE PROFILE FOR THE COMPUTED 100-YEAR FLOOD, SWIFT CREEK AT AFTON, WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div. For primary bibliographic entry see Field 7C.
W90-05192

LOW-FLOW CHARACTERISTICS OF STREAMS IN WEST VIRGINIA.

Geological Survey, Charleston, WV. Water Resources Div. E. A. Friel, W. N. Embree, A. R. Jack, and J. T. Atkins. Available from Books and Open-File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4072, 1989. 34p, 12 fig, 2 tab, 15 ref.

Descriptors: *Low flow, *Estimating equations, *West Virginia, *Recession curve, *Statistical analysis, Streamflow, Regional analysis, Drainage area, Flow duration, Gaging stations.

Low-flow characteristics of selected streams in West Virginia were determined at continuous-record and partial-record sites. Daily discharges at 100 continuous-record gaging stations on unregulated streams were used to compute selected low-flow frequency values. Estimates of low-flow frequency values at 296 partial-record sites (ones having only discharge measurements) were made using the relation defined by concurrent flows with a continuous-record station. Low-flow characteristics at continuous-record stations were related to drainage area and a variability index to produce equations which can be used to estimate low-flow characteristics at ungaged sites in West Virginia. The State was divided into two hydrologic regions. Drainage area and a streamflow-variability index were determined to be the most significant. The streamflow variability index was computed from duration curves and was used to account for the integrated effects of geology and other hydrologic characteristics. The standard error of estimate for the 7-day low flow with a 2-year recurrence interval is 43% for Region 1 and 57% for Region 2. The standard error of estimate for the 7-day low flow with a 10-year recurrence interval is 82% for Region 1 and 83% for Region 2. (USGS)
W90-05203

ESTIMATES OF MONTHLY STREAMFLOW CHARACTERISTICS AT SELECTED SITES IN THE UPPER MISSOURI RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1937-86.

Geological Survey, Helena, MT. Water Resources Div. C. Parrett, D. R. Johnson, and J. A. Hull. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4082, Sept. 1989. 121p, 4 fig, 17 tab, 11 ref.

Descriptors: *Streamflow, *Missouri River Basin, *Channel morphology, *Montana, *Water resources data, *Hydrologic data, Low flow, Data collections.

Estimates of streamflow characteristics (monthly mean flow that is exceeded 90, 80, 50, and 20 percent of the time for all years of record and mean monthly flow) were made and are presented in tabular form for 312 sites in the Missouri River basin in Montana. Short-term gaged records were extended to the base period of water years 1937-86, and were used to estimate monthly streamflow characteristics at 100 sites. Data from 47 gaged sites were used in regression analysis relating the streamflow characteristics to basin characteristics and to active-channel width. The basin-characteristics equations, with standard errors of 35% to 97%, were used to estimate streamflow characteristics at 179 ungaged sites. The channel-width equations, with standard errors of 36% to 103%, were used to estimate characteristics at 138 ungaged sites. Streamflow measurements were correlated with concurrent streamflows at nearby gaged sites to estimate streamflow characteristics at 139 ungaged sites. In a test using 20 pairs of gages, the standard errors ranged from 31% to 111%. At 139 ungaged sites, the estimates from two or more of the methods were weighted and combined in accordance with the variance of individual methods. When estimates from three methods were combined the standard errors ranged from 24% to 63%. A drainage-area-ratio adjustment method was used to estimate monthly streamflow characteristics at seven ungaged sites. The reliability of the drainage-area-ratio adjustment method was estimated to be about equal to that of the basin-characteristics method. The estimate was checked for reliability. Estimates of monthly streamflow characteristics from gaged records were considered to be most reliable, and estimates at sites with

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actual flow record from 1937-86 were considered to be completely reliable (zero error). Weighted-average estimates were considered to be the most reliable estimates made at ungaged sites. (USGS) W90-05205

TRENDS IN SELECTED WATER-QUALITY VARIABLES, FLATHEAD RIVER AT FLATHEAD, BRITISH COLUMBIA, AND AT COLUMBIA FALLS, MONTANA, WATER YEARS 1975-86.
Geological Survey, Billings, MT. Water Resources Div.
For primary bibliographic entry see Field 5B. W90-05206

WATER RESOURCES AND ESTIMATED EFFECTS OF GROUNDWATER DEVELOPMENT, CECIL COUNTY, MARYLAND.
Maryland Geological Survey, Baltimore. E. G. Otton, R. E. Willey, R. A. McGregor, G. Ahmad, and S. N. Hjordahl.
Available from Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218. Bulletin 34, 1988. 133p, 32 fig, 6 plates, 30 tab, 63 ref, append.

Descriptors: *Data collections, *Groundwater data, *Surface water data, *Water quality, *Water resources data, *Gaging stations, *Maryland, Cecil County, Aquifers, Bottom sediments, Environmental quality, Groundwater level, Groundwater flow models, Observation wells, Pesticide residues, Potentiometric level, Streams, Trace elements, Water table.

In the crystalline rock of the Piedmont of Cecil County, Maryland, water is present in openings caused by fracturing and weathering. In the Coastal Plain sediments, water is present between grains. The median yield of wells in crystalline rock is 10 gal/min. The major aquifers in Cecil County are the upper and lower Potomac aquifers. Yields of wells in the Potomac aquifers range from 0.5 to 703 gal/min and the median is 30 gal/min. Reported yields of 50 wells in the Magothy aquifer range from 7 to 270 gal/min; the median is 30 gal/min. Reported yields of 25 wells that tap the Monmouth aquifer range from 8 to 42 gal/min; the median is 20 gal/min. Decline of the water table in the Piedmont area caused by pumping tends to be local. By contrast, pumping from the Potomac aquifers causes widespread reduction in water level. Common chemical quality problems are excessive iron concentrations and low pH. Dissolved solids generally are low; only three groundwater samples had dissolved-solids concentrations greater than 500 mg/L. Streamflow data were measured at 10 continuous-record and 27 partial-record stations. Total runoff is about 20 in/year. Dissolved-solids concentrations in base-flow samples ranged from 39 to 256 mg/L. Synthetic organic compounds were detected at 6 of 10 streambed-sediment sampling sites. Groundwater flow models were constructed for three areas. Maximum drawdowns greater than 40 ft were projected under sewered, drought conditions in the Elkton-Chesapeake City area; maximum drawdowns greater than 20 ft were simulated under the same conditions in the Rising Sun and Highlands-Meadow View areas. (USGS) W90-05208

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN TEXAS—FISCAL YEAR 1988.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05213

FLOW AND HYDRAULIC CHARACTERISTICS OF THE KNIK-MATANUSKA RIVER ESTUARY, COOK INLET, SOUTHCENTRAL ALASKA.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 2L. W90-05215

ASSESSMENT OF PROCESSES AFFECTING LOW-FLOW WATER QUALITY OF CEDAR CREEK, WEST-CENTRAL ILLINOIS.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 5B. W90-05223

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1985.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05235

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1984.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05236

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1984.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05237

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1984.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05238

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1985.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05239

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1983.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05240

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1984.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05241

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1985.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05242

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05243

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05244

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05245

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1984.
Geological Survey, Jacksonville, FL. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05246

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1984.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05247

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1985.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05248

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05249

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984. VOLUME 2, COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05250

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1985. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05251

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1984.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05252

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1984.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05253

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984. VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-05254

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984. VOLUME 2. DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Trenton, NJ. Water Resources Div.

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Div.

For primary bibliographic entry see Field 7C.
W90-05255

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985. VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7C.
W90-05256

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985. VOLUME 2. DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7C.
W90-05257

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1984.

Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05258

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1985.

Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05259

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1987. VOLUME 1. EASTERN OREGON.

Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05260

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1987. VOLUME 2. WESTERN OREGON.

Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05261

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1987.

Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05262

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 2. LONG ISLAND.

Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05263

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 3. WESTERN NEW YORK.

Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05264

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1988. VOLUME 1, HAWAII.

Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05265

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1987.

Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05266

ESTIMATES OF MEAN MONTHLY STREAMFLOW FOR SELECTED SITES IN THE MUSSELHELL RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1937-86.

Geological Survey, Helena, MT. Water Resources Div.
C. Parrett, and D. R. Johnson.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4165, January, 1990. 31p, 2 fig, 13 tab, 11 ref.

Descriptors: *Streamflow, *Water resources data, *Hydrologic data, *Montana, *Musselshell River Basin, Low flow, Channel morphology.

Estimates of mean monthly and mean annual streamflow were made for 56 selected sites in the Musselshell River basin and 1 site outside the basin. The study area was divided into a Mountain Region and a Plains Region and the estimation methods were applied separately in the two regions. Four methods were developed to estimate mean monthly streamflow at ungaged sites. The first method was based on the regression relation between mean monthly streamflow and various basin and climatic characteristics. The standard errors ranged from 35 to 71% in the Mountain Region and from 98 to 157% in the Plains Region. The second method was based on the regression relations between mean monthly streamflow and active-channel width. The standard errors ranged from 38 to 81% in the Mountain Region and from 71 to 98% in the Plains Region. The third method was based on correlation of measured streamflow at ungaged sites with concurrent daily mean streamflow at nearby gaged sites. The standard errors ranged from 36 to 66% in the Mountain Region and from 109 to 321% in the Plains Region. The fourth method, generally the most reliable, estimated mean monthly streamflows by weighing individual estimates in accordance with their variance and degree of independence. The standard error for this method when all three individual estimates were weighed ranged from 25 to 55% in the Mountain Region and from 71 to 97% in the Plains Region. (USGS)
W90-05267

STATISTICAL SUMMARIES OF STREAMFLOW DATA IN NEW MEXICO THROUGH 1985.

Geological Survey, Albuquerque, NM. Water Resources Div.
S. D. Waltemeyer.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225; price codes. USGS Water-Resources Investigations Report 88-42248, Nov. 1989. 204p, 4 fig, 6 ref.

Descriptors: *Water resources data, *Hydrologic data, *Stream discharge, Discharge frequency, Flow duration, Low flow, High flow, Regulated flow, Frequency analysis, Gaging stations, Surface runoff, Statistics, Probability distribution.

Statistical summaries of streamflow data collected at selected gaging stations are presented to aid in appraising the hydrology of New Mexico. Streamflow records are presented for 169 gaging stations for their period of record. Records for 17 stations are separated into periods before, after, and between changes in upstream regulation. For each gaging station, a brief description is given for station location, drainage area, period of record, revisions of previously published records, type and history of gages, regulation and diversions, average discharge, and extremes of discharge. These data are followed by statistical summaries of mean monthly and mean annual flow statistics, low-flow and high-flow frequency, and flow-duration information. (USGS)
W90-05269

WATER RESOURCE OF SEDGWICK COUNTY, KANSAS.

Geological Survey, Lawrence, KS. Water Resources Div.
H. E. Bevans.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4225, 1989. 119p, 22 fig, 2 plates, 18 tab, 65 ref.

Descriptors: *Water resources data, *Areal hydrogeology, *Water quality, *Water use, *Surface water, *Groundwater, *Streamflow, *Kansas, Groundwater level, Arkansas River Basin, Sedgwick County, Wichita.

Hydrologic data from streams, impoundments, and wells are interpreted to: (1) document water resources characteristics; (2) describe causes and extent of changes in water resources characteristics; and (3) evaluate water resources as sources of supply. During 1985, about 134,200 acre-ft of water (84% groundwater) were used for public (42%), irrigation, (40%), industrial (14%), and domestic (4%) supplies. Streamflow and groundwater levels are related directly to precipitation, and major rivers are sustained by groundwater inflow. Significant groundwater level declines have occurred only in the Wichita well field. The Arkansas and Neosho Rivers have sodium chloride type water; the Little Arkansas River, calcium bicarbonate type water. Water quality characteristics of water in small streams and wells depend primarily on local geology. The Wellington Formation commonly yields calcium sulfate type water; Neosho Shale and unconsolidated deposits generally yield calcium bicarbonate type water. Sodium chloride and calcium sulfate type water in the area often have dissolved-solids concentrations exceeding 1,000 mg/L. Water contamination by treated sewage effluent was detected in parts of the Arkansas River, Little Arkansas River, and Cowkin Creek. Nitrite plus nitrate as nitrogen contamination was detected in 11 of 101 wells; oilfield brine was detected in the Wichita-Valley Center Floodway, Prairie Creek, Whitewater Creek, and 16 of 101 wells; and agricultural pesticides were detected in 8 of 14 impoundments and 5 of 19 wells. Generally, the water is acceptable for most uses. (USGS)
W90-05270

APPLICATION OF THE PRECIPITATION-RUNOFF MODELING SYSTEM TO THE AHSI-SLE-PAH WASH WATERSHED, SAN JUAN COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-05272

FRESHWATER WITHDRAWALS AND WATER-USE TRENDS IN FLORIDA, 1985.

Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 6D.
W90-05279

SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN COLORADO—FISCAL YEAR 1989.

Geological Survey, Denver, CO. Water Resources Div.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-588, 1990. 58p, 1 pl, 1 tab. Compile by P. A. Griffith.

Descriptors: *Water resources data, *Hydrologic data, *Colorado, *Groundwater, *Surface water, *Water quality, Hydrology, Surface water records.

The biennial summary of water resources activities in Colorado is presented for fiscal year 1989. The report includes an introduction of these activities and names of the management personnel to whom information requests may be addressed, a summary of the U.S. Geological Survey mission and of the Water Resources Division mission, and a discussion of the water resources in Colorado in fiscal year 1989, including data collection on surface

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water and groundwater. All current Colorado hydrologic investigations are listed—their problems, objectives, approaches, progress, and plans for fiscal year 1989. A list of current cooperators, for fiscal year 1989 and a list of reports published or released during fiscal years 1987, 1988, and 1989 also are given. (USGS)
W90-05281

STATUS AND IMPLICATIONS OF THE INVASION OF TAMARISK (TAMARIX APHYLLA) ON THE FINKE RIVER, NORTHERN TERRITORY, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Alice Springs (Australia). Div. of Wildlife and Rangelands Research.
For primary bibliographic entry see Field 2H.
W90-05294

YOUNG FISH DISTRIBUTION IN BACKWATERS AND MAIN-CHANNEL BORDERS OF THE KANAWHA RIVER, WEST VIRGINIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 2H.
W90-05296

OPTIMIZING SPILLWAY CAPACITY WITH UNCERTAINTY IN FLOOD ESTIMATOR.
California Univ., Davis. Dept. of Land, Air and Water Resources.
A. Afshar, and M. A. Marino.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 71-84, January/February 1990. 9 fig, 21 ref, 2 append.
Agricultural Research Service Cooperative Agreement 4116-H.

Descriptors: *Dams, *Flood forecasting, *Runoff forecasting, *Water yield forecasting, *Dam design, *Spillways, Dam failure, Flood control, Model studies, Design criteria.

The spillway design flood is a function of social, moral, economic, and technological restrictions. Given the significant initial cost of a spillway and the very high cost of dam failure and downstream damages, the economic sizing of the spillway becomes a very important decision. A model that minimizes the social cost of a spillway is presented. The model incorporates the uncertainty of the flood magnitude estimator in the optimization of spillway capacity, using an estimated flood probability density function and a relationship between spillway capacity and cost. The spillway design flood is explicitly treated as a decision variable, which is useful in the planning phase of a reservoir. To determine the effect of uncertainty in the flood magnitude estimator, the optimum spillway design flood is examined for different flood probability density functions with varying sample sizes. It is shown that with a limited sample size, the optimum spillway design flood may be as high as the probable maximum flood. (Author's abstract)
W90-05303

DIET AND SEASONAL DRIFT OF ZOOPLANKTON IN A HEADWATER STREAM.
Arkansas Univ., Fayetteville. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-05311

SEASONAL RHYTHMS AND COMPONENTS BY STATION IN THE AQUATIC ENVIRONMENT: II. TAKING INTO ACCOUNT AND ELIMINATING THEIR EFFECTS FROM A FAUNISTIC CATALOG (RHYTHMES SAISONNIERS ET COMPOSANTES STATIONNELLES EN MILIEU AQUATIQUE: II. PRISE EN COMPTE ET ELIMINATION D'EFFETS DANS UN TABLEAU FAUNISTIQUE).
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 2H.
W90-05337

NUTRIENT CYCLING IN THE EPILITHON OF RUNNING WATERS.

Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05352

TOWARDS A BIOLOGICAL AND CHEMICAL DEFINITION OF THE HYPORHEIC ZONE IN TWO CANADIAN RIVERS.
Toronto Univ. (Ontario). Div. of Life Sciences.
For primary bibliographic entry see Field 2F.
W90-05358

PERIPHYTON BIOMASS DYNAMICS IN GRAVEL BED RIVERS: THE RELATIVE EFFECTS OF FLOWS AND NUTRIENTS.
Department of Scientific and Industrial Research, Christchurch (New Zealand). Hydrology Centre.
For primary bibliographic entry see Field 2H.
W90-05359

MICROHABITAT AVAILABILITY IN WELSH MOORLAND AND FOREST STREAMS AS A DETERMINANT OF MACROINVERTEBRATE DISTRIBUTION.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 2H.
W90-05360

VERTICAL DISTRIBUTION AND ABUNDANCE OF INVERTEBRATES WITHIN THE SANDY SUBSTRATE OF A LOW-GRADIENT HEADWATER STREAM.
For primary bibliographic entry see Field 2H.
W90-05361

HYDROLYTIC EXTRACELLULAR ENZYME ACTIVITY IN HETEROTROPHIC BIOFILMS FROM TWO CONTRASTING STREAMS.
University Coll. of North Wales, Bangor. School of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-05363

DISTRIBUTION OF MACROINVERTEBRATE COMMUNITIES IN TWO PORTUGUESE RIVERS.
Coimbra Univ. (Portugal). Dept. de Zoologia.
For primary bibliographic entry see Field 2H.
W90-05364

ALGAL EPILITHON AND WATER QUALITY OF A STREAM RECEIVING OIL REFINERY EFFLUENT.
North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-05372

RAPID GROWTH RATES OF CHIRONOMIDS IN THREE HABITATS OF A SUBTROPICAL BLACKWATER RIVER AND THEIR IMPLICATIONS FOR P:B RATIOS.
Emory Univ., Atlanta, GA. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05395

INFLUENCE OF RESERVOIRS ON THE HYDROLOGICAL REGIME OF THE KUR RIVER.
Akademiya Nauk Azerbaizhanskoi SSR, Baku. Inst. of Geography.
For primary bibliographic entry see Field 4A.
W90-05474

CLIMATIC AND HYDROLOGIC EFFECTS ON THE REGENERATION OF POPULUS ANGUSTIFOLIA JAMES ALONG THE ANIMAS RIVER, COLORADO.
Wisconsin Univ.-Madison. Dept. of Geography.
For primary bibliographic entry see Field 2I.
W90-05490

CHARACTERISTICS OF RIPARIAN PLANT COMMUNITIES AND STREAMBANKS WITH

RESPECT TO GRAZING IN NORTHEASTERN UTAH.
Intermountain Forest and Range Experiment Station, Boise, ID.
For primary bibliographic entry see Field 4D.
W90-05503

EFFECTS OF VEGETATION AND LAND USE ON CHANNEL MORPHOLOGY.
Wisconsin Univ.-Madison. Dept. of Geography.
For primary bibliographic entry see Field 4C.
W90-05509

HABITAT USE BY BEAVER ALONG THE BIG SIOUX RIVER IN EASTERN SOUTH DAKOTA.
South Dakota State Univ., Brookings. Dept. of Wildlife and Fisheries.
For primary bibliographic entry see Field 2H.
W90-05511

APPLICATION OF THE PRECIPITATION-RUNOFF MODELING SYSTEM TO THE AHSI-SLE-PAH WASH WATERSHED, SAN JUAN COUNTY, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-05547

FLOOD OF SEPTEMBER 7-9, 1987, IN LEXINGTON AND RICHLAND COUNTIES IN THE VICINITY OF SAINT ANDREWS ROAD AND IRMO, SOUTH CAROLINA.
Geological Survey, Columbia, SC. Water Resources Div.
W. B. Guimaraes.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4077, 1989. 37p, 18 fig, 5 tab, 12 ref.

Descriptors: *Flood damage, *Flood maps, *Floods, *South Carolina, Lexington County, Richland County, Rainfall intensity, Flood peak, Rawls Creek, Kinley Creek, High water mark.

Localized heavy rainfall on September 7, 1987, in Lexington and Richland Counties, South Carolina, caused severe flooding in the basins of Kinley Creek, Rawls Creek, and Stoop Creek, in the vicinity of Saint Andrews Road and the town of Irmo, South Carolina. The flooding damaged homes, furnishings, and landscaping. Rainfall, peak discharges, high water elevations, and frequency relations of rainfall and discharge are tabulated and plotted for selected streams. The rain was most intense in the area along Rawls Creek, R-2 (tributary to Rawls Creek), Koon Branch (tributary to Rawls Creek), and the upper part of Kinley Creek. A rainfall of about 5.5 inches in 3 hours, which has a recurrence interval in excess of 100 years was reported by local residents along these streams. High water marks for the flood of September 7, 1987, are shown for eight stream reaches in the area. High water marks are also shown for the flood of September 9, 1987, on K-1. Profiles for the 100-year flood developed by the Federal Emergency Management Agency (FEMA) in a 1980 flood insurance mapping study are shown for comparison purposes for five of the stream reaches. Peak discharges were computed at 16 sites in the area by using indirect measurement techniques. Peak discharges ranged from about 100 cu ft/sec at the site on a small unnamed tributary to Kinley Creek to 3,500 cu ft/sec at the Rawls Creek site at Nursery Road. Peak discharges at the most downstream sites on Rawls Creek and Koon Branch had recurrence intervals of 75 years, and 60 years, respectively. Peak discharges on Kinley Creek varied from 20 to 25 years north of K-1 basin to < 10 years at K-1. The Stoop Creek basin had a recurrence interval of 10 years. Peak discharges for selected recurrence intervals computed by the US Geological Survey and presented in this flood report agree reasonably well with those computed by FEMA in a 1980 study using different computational procedures. (Lantz-PTT)
W90-05549

Field 2—WATER CYCLE

Group 2E—Streamflow and Runoff

STREAMFLOW AND WATER-QUALITY DATA FOR LITTLE CLEARFIELD CREEK BASIN, CLEARFIELD COUNTY, PENNSYLVANIA, DECEMBER 1987-NOVEMBER 1988.

Geological Survey, Harrisburg, PA. Water Resources Div.
K. M. Kostelnik, and R. R. Durlin.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-247, 1989. 30p, 4 fig, 14 tab, 16 ref.

Descriptors: *Streamflow, *Water quality, *Hydrologic data collections, *Pennsylvania, Hydrogen ion concentration, Specific conductivity, Water temperature, Heavy metals, Streamflow data, Little Clearfield Creek Basin, Suspended sediments.

Streamflow and water quality data were collected throughout the Little Clearfield Creek basin, Clearfield County, Pennsylvania, from December 1987 through November 1988, to determine the existing quality of surface water over a range of hydrologic conditions. This data will assist the Pennsylvania Department of Environmental Resources during its review of coal mine permit applications. A water quality station near the mouth of Little Clearfield Creek provided continuous record of stream stage, pH, specific conductance, and water temperature. Monthly water quality samples collected at this station were analyzed for total and dissolved metals, nutrients, major cations, and suspended sediment concentrations. Seventeen partial record sites, located throughout the basin, were similarly sampled four times during the study. Streamflow and water quality data obtained at these sites during a winter base flow, a spring storm event, a low summer base flow, and a more moderate summer base flow also are presented. (Author's abstract)
W90-05552

SIMULATION OF RAINFALL-RUNOFF RESPONSE IN MINED AND UNMINED WATERSHEDS IN COAL AREAS OF WEST VIRGINIA.

For primary bibliographic entry see Field 4A.
W90-05560

PEAK-FLOW DATA-COLLECTION METHODS FOR STREAMS IN ARID AREAS.

Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-05596

LOW-FLOW PROFILES OF THE TALLAPOOSA RIVER AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.
R. F. Carter, E. H. Hopkins, and H. A. Perlman.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4050, 1988. 39p, 1 fig, 12 ref.

Descriptors: *Georgia, *Low flow, *Tallapoosa River, *Hydrologic data collections, Streamflow, Flow profiles, Drainage area, Flow discharge.

Low flow information is provided for use in an evaluation of the capacity of streams to permit withdrawal or to accept waste loads without exceeding the limits of State water quality standards. The report is the fourth in a series of reports presenting the results of a low flow study of all stream basins north of the Fall Line in Georgia. This report covers the part of the Tallapoosa River basin in the Piedmont province of Georgia. The low flow characteristic presented is the minimum average flow for 7 consecutive days with a 10-year recurrence interval (7Q10). The data are presented in tables and shown graphically as 'low flow profiles' (low flow plotted against distance along a stream channel), and as 'drainage area profiles' (drainage area plotted against distance along a stream channel). Low flow profiles were constructed by interpolation or extrapolation from points of known low flow data. Low flow profiles

are included for all stream reaches where low flow data of sufficient accuracy are available to justify computation of the profiles. Drainage area profiles are included for all stream basins > 5 sq mi, except for those in a few remote areas. Flow records were not adjusted for diversions or other factors that cause measured flows to represent conditions other than natural flow. (Author's abstract)
W90-05601

ESTIMATING FLOOD HYDROGRAPHS FOR ARKANSAS STREAMS.

Geological Survey, Little Rock, AR. Water Resources Div.
B. L. Neely.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4109, 1989. 19p, 4 fig, 4 tab, 8 ref.

Descriptors: *Flood hydrographs, *Hydrograph analysis, *Flood forecasting, *Data interpretation, *Arkansas, *Streamflow, Flood peak, Regression analysis, Mathematical analysis, Drainage area.

Flood hydrographs are needed for the design of many highway drainage structures and embankments and flood water storage structures. A dimensionless hydrograph is presented for Arkansas streams having drainage areas < 600 sq mi. This dimensionless hydrograph can be used with peak discharge and equivalent lagtime to determine flood hydrographs at ungaged sites on rural and urban streams in Arkansas. Multiple regression analysis was used to define relations between equivalent lagtime and basin, climatic, and hydrologic characteristics. Data collected on 450 storms at 9 gaging stations were used in the analysis. The regression analysis indicated that drainage area and 100-year discharge are significant parameters for estimating equivalent lagtime. The standard error of the regression equation is $\pm 38\%$. The equation was tested for accuracy, bias, and sensitivity. An equation is presented for computing the volume of flood runoff when the peak discharge, equivalent lagtime, and drainage area are known. In addition, a hydrograph-width relation is presented for estimating the length of time that a specific discharge will be exceeded. (Lantz-PTT)
W90-05602

WATER RESOURCES OF SEDGWICK COUNTY, KANSAS.

Geological Survey, Lawrence, KS. Water Resources Div.
H. E. Bevans.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4225, 1989. 119p, 22 fig, 18 tab, 2 plates, 65 ref.
Descriptors: *Water resources data, *Water resources, *Water demand, *Sedgwick County, *Kansas, *Water quality, Groundwater quality, Water use, Arkansas River, Little Arkansas River, Oil wastes, Pesticides, Water chemistry, Nitrates, Nitrites, Nutrients, Atrazine, Heptachlor.

The large population and diverse economic activities in Sedgwick County and its principal city, Wichita, require adequate water supplies for public, domestic, irrigation, and industrial uses. During 1985, an estimated 134,200 acre-ft of water (84% groundwater) were used for public supplies (42%), irrigation (40%), self-supplied industrial use (14%), and self-supplied domestic use (4%). The city of Wichita used about 53,500 acre-ft of water for public supplies. Streamflow is closely related to precipitation, and major streams are sustained by groundwater inflow. Water in the Arkansas River is a NaCl type, with a median dissolved solids concentration of 1,700 mg/L at Hutchinson and 1,200 mg/L at Derby. The Little Arkansas River at Valley Center has a CaHCO₃ type water, with a median dissolved solids concentration of 480 mg/L. Contamination of streams by sewage treatment plant effluent was indicated by increased ammonia concentrations in the Arkansas River at Derby and Mulvane, in the Little Arkansas River near Sedgwick, and in Cowdin Creek near Maize and at the Sumner County line. Agricultural pesticides or the

pesticide residue, heptachlor epoxide, were detected in 8 of 14 impoundments. Groundwater contamination by oilfield brines was indicated in 16 of 101 sampled wells. Nitrite-plus-nitrate as nitrogen concentrations exceeded 10 mg/L in water from 11 of 101 sampled wells. Iron concentrations exceeded 300 micrograms/L in water from 18 of 101 wells, and manganese concentrations exceeded 50 microg/L in water from 31 of 101 wells. Herbicides (atrazine, metalochlor, propazine, and simazine) were detected in water from 5 or 19 wells, and a volatile organic compound (trichloroethylene) was detected in water from 1 of 10 wells. (Lantz-PTT)
W90-05605

MEASUREMENT OF REAERATION COEFFICIENTS FOR SELECTED FLORIDA STREAMS.

Geological Survey, Tallahassee, FL. Water Resources Div.
P. S. Hampson, and J. E. Coffin.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4020, 1989. 81p, 49 fig, 3 tab, 37 ref, 1 map, append.

Descriptors: *Water quality, *Aeration, *Florida, *Streams, *Hydrologic data collections, Ethylene, Propane, Mathematical equations.

A total of 29 separate reaeration coefficient determinations were performed on 27 subreaches of 12 selected Florida streams between October 1981 and May 1985. Measurements performed prior to June 1984 were made using the peak and area methods with ethylene and propane as the tracer gases. Later measurements utilized the steady-state method with propane as the only tracer gas. The reaeration coefficients ranged from 1.07 to 45.9 days with a mean estimated probable error of $\pm 16.7\%$. Ten predictive equations (compiled from the literature) were also evaluated using the measured coefficients. The most representative equation was one of the energy dissipation type with a standard error of 60.3%. Seven of the 10 predictive additional equations were modified using the measured coefficients and nonlinear regression techniques. The most accurate of the developed equations was also of the energy dissipation form and had a standard error of 54.9%. For 5 of the 13 subreaches in which both ethylene and propane were used, the ethylene data resulted in substantially larger reaeration coefficient values which were rejected. In these reaches, ethylene concentrations were probably significantly affected by one or more electrophilic addition reactions known to occur in aqueous media. (Author's abstract)
W90-05606

SEDIMENT TRANSPORT AND ACCRETION AND THE HYDROLOGIC ENVIRONMENT OF GROVE CREEK NEAR KENANSVILLE, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2J.
W90-05609

WATER QUALITY AND RESTORATION OF THE LOWER OCONTO RIVER, OCONTO COUNTY, WISCONSIN.

Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5G.
W90-05610

POPULATION DYNAMICS OF SMALL-MOUTH BASS (MICROPTERUS DOLOMIEUI) IN THE GALENA (FEVER) RIVER AND ONE OF ITS TRIBUTARIES.

Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 2H.
W90-05611

LOW-FLOW PROFILES OF THE TENNESSEE RIVER TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.

Groundwater—Group 2F

R. F. Carter, E. H. Hopkins, and H. A. Perlman. Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 88-4049, 1988. 69p, 1 fig, 12 ref.

Descriptors: *Low flow, *Tennessee River, *Hydrologic data collections, *Georgia, *Streamflow, *Flow profiles, Drainage area, Flow discharge.

Low flow information is provided for use in an evaluation of the capacity of streams to permit withdrawals or to accept waste loads without exceeding the limits of State water quality standards. The purpose of this report is to present the results of a compilation of available low flow data in the form of tables and '7Q10 flow profiles' (minimum average flow for 7 consecutive days with a 10-yr recurrence interval) (7Q10 flow plotted against distance along a stream channel) for all stream reaches of the Tennessee River tributaries where sufficient data of acceptable accuracy are available. Drainage area profiles are included for all stream basins larger than 5 sq mi, except for those in a few remote areas. This report is the fifth in a series of reports that will cover all stream basins north of the Fall Line in Georgia. It includes the parts of the Tennessee River basin in Georgia. Flow records were not adjusted for diversions or other factors that cause measured flows to represent other than natural flow conditions. The 7-day minimum flow profile was omitted for stream reaches where natural flow was known to be altered significantly. (Lantz-PTT) W90-05612

LOW-FLOW PROFILES OF THE UPPER SAVANNAH AND OGEECHEE RIVERS AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.

R. F. Carter, E. H. Hopkins, and H. A. Perlman. Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 88-4047, 1988. 169p, 1 fig, 12 ref.

Descriptors: *Low flow, *Savannah River, *Ogeechee River, *Hydrologic data collections, *Georgia, *Streamflow, *Flow profiles, Drainage area, Flow discharge.

Low flow information is provided for use in an evaluation of the capacity of streams to permit withdrawals or to accept waste loads without exceeding the limits of State water quality standards. The purpose of this report is to present the results of a compilation of available low flow data in the form of tables and '7Q10 flow profiles' (minimum average flow for 7 consecutive days with a 10-yr recurrence interval) (7Q10 flow plotted against distance along a stream channel) for all stream reaches of the Upper Savannah and Ogeechee Rivers and tributaries where sufficient data of acceptable accuracy are available. Drainage area profiles are included for all stream basins larger than 5 sq mi, except for those in a few remote areas. This report is the third in a series of reports that will cover all stream basins north of the Fall Line in Georgia. It includes the Georgia part of the Savannah River basin from its headwaters down to and including McBean Creek, and Brier Creek from its headwaters down to and including Boggy Gut Creek. It also includes the Ogeechee River from its headwaters down to and including Big Creek, and Rocky Comfort Creek (tributary to Ogeechee River) down to the Glascock-Jefferson County line. Flow records were not adjusted for diversions or other factors that cause measured flows to represent other than natural flow conditions. The 7-day minimum flow profile was omitted for stream reaches where natural flow was known to be altered significantly. (Lantz-PTT) W90-05613

LOW-FLOW PROFILES IN THE UPPER OCONEE RIVER AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.

R. F. Carter, E. H. Hopkins, and H. A. Perlman.

Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 88-4048, 1988. 136p, 1 fig, 13 ref.

Descriptors: *Low flow, *Oconee River, *Hydrologic data collections, *Streamflow, *Georgia, *Flow profiles, Drainage area, Flow discharge.

Low flow information is provided for use in an evaluation of the capacity of streams to permit withdrawals or to accept waste loads without exceeding the limits of State water quality standards. The purpose of this report is to present the results of a compilation of available low flow data in the form of tables and '7Q10 flow profiles' (minimum average flow for 7 consecutive days with a 10-yr recurrence interval) (7Q10 flow plotted against distance along a stream channel) for all stream reaches of the Upper Oconee River and tributaries in Georgia where sufficient data of acceptable accuracy are available. Drainage area profiles are included for all stream basins larger than 5 sq mi, except for those in a few remote areas. This report is the second in a series of reports that will cover all stream basins north of the Fall Line in Georgia. It includes the Oconee River basin down to and including Camp Creek at stream mile 134.53, Town Creek in Baldwin and Hancock Counties down to County Road 213-141, and Buffalo Creek in Hancock County down to the Hancock-Washington County line. Flow records were not adjusted for diversions or other factors that cause measured flows to represent other than natural flow conditions. The 7-day minimum flow profile was omitted for stream reaches where natural flow was known to be altered significantly. (Lantz-PTT) W90-05614

ECOLOGY OF THE LOWER COLORADO RIVER FROM DAVIS DAM TO THE MEXICO-UNITED STATES INTERNATIONAL BOUNDARY: A COMMUNITY PROFILE.

Arizona State Univ., Tempe. Center for Environmental Studies.

For primary bibliographic entry see Field 6G. W90-05616

2F. Groundwater

RISK ASSESSMENT OF GROUNDWATER CONTAMINATION AND CURRENT APPLICATIONS IN THE DECISION-MAKING PROCESS.

United Technologies Corp., East Hartford, CT. For primary bibliographic entry see Field 5A. W90-04606

INFLUENCE OF RIMING ON THE CHEMICAL COMPOSITION OF SNOW IN WINTER OROGRAPHIC STORMS.

Nevada Univ. System, Reno. Atmospheric Sciences Center. For primary bibliographic entry see Field 2C. W90-04608

ANALYTICAL SOLUTION OF A CONVECTION-DISPERSION MODEL WITH TIME-DEPENDENT TRANSPORT COEFFICIENTS.

Western Australia Univ., Nedlands. Centre for Water Research. For primary bibliographic entry see Field 5B. W90-04658

SIMULATION OF THREE-DIMENSIONAL FLOW OF IMMISCIBLE FLUIDS WITHIN AND BELOW THE UNSATURATED ZONE.

GeoTrans, Inc., Herndon, VA. For primary bibliographic entry see Field 5B. W90-04662

STOCHASTIC ANALYSIS OF THE INFLUENCE OF SOIL AND CLIMATIC VARIABILITY ON THE ESTIMATE OF PESTICIDE GROUNDWATER POLLUTION POTENTIAL.

California Univ., Riverside. Dept. of Soil and En-

vironmental Sciences.

For primary bibliographic entry see Field 5B. W90-04663

HYDROSTRATIGRAPHIC INTERPRETATION USING INDICATOR GEOSTATISTICS.

California Univ., Santa Cruz. Dept. of Earth Sciences. N. M. Johnson, and S. J. Dreiss.

Water Resources Research WRERAQ, Vol. 25, No. 12, p 2501-2510, December 1989. 16 fig, 3 tab, 35 ref. U.S. Geological Survey Water Resources Research Grant Program, grant 14-08-0001-G1311.

Descriptors: *Geohydrology, *Well log interpretation, *Path of pollutants, *Alluvial deposits, *Stratigraphy, Boreholes, Geostatistics, Kriging, Variograms, Santa Clara Valley, California.

An approach that uses indicator geostatistics to interpret qualitative borehole logs and compute experimental variograms for complex alluvial sediments is presented. Borehole descriptions are first transformed into binary indicator values based on inferred relative permeability from the borehole descriptions. The resulting indicator data can then be used to compute variograms and construct three-dimensional variogram models. The ranges of computed indicator variograms for a groundwater contamination site in Santa Clara Valley, California, are very sensitive to the orientation of the search plane. These variograms are consistent with known stratigraphic features and describe the spatial structure of deposits from different depositional environments. Indicator kriging weights all the available data on the basis of a three-dimensional, anisotropic variogram model and provides an estimate of uncertainty in the hydrostratigraphic correlation. Kriged indicator values represent probabilities that sediments at a specific location fall into one of two indicator categories. The location of the 0.5 indicator contour is approximately the boundary between high-permeability and low-permeability sediments that might be constructed in a geologic cross section. (Author's abstract) W90-04667

ENVIRONMENTAL FACTORS AFFECTING PHYSIOGNOMIC AND FLORISTIC VARIATION IN AN AREA OF CERRADO IN CENTRAL BRAZIL.

Escola Superior de Agricultura de Lavras (Brazil). Dept. de Ciencias Florestais. For primary bibliographic entry see Field 2H. W90-04725

AGRICULTURAL CONTAMINATION: PROBLEMS AND SOLUTIONS.

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab. For primary bibliographic entry see Field 5B. W90-04876

WELLFIELD DEVELOPMENT FOR URBAN WATER SUPPLIES IN PDR YEMEN.

For primary bibliographic entry see Field 5F. W90-04913

COMPUTER ANALYSIS OF REGIONAL GROUNDWATER FLOW AND BOUNDARY CONDITIONS IN THE BASIN OF MEXICO.

Universidad Nacional Autonoma de Mexico, Mexico City. A. Ortega G., and R. N. Farvolden. Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 271-294, October 1989. 7 fig, 4 tab, 44 ref.

Descriptors: *Groundwater movement, *Mexico, *Mathematical models, *Geohydrology, *Volcanic aquifers, *Model studies, *Boundary conditions, *Computer models, Regional analysis, Aquifers, Finite element method, Hydraulic conductivity, Infiltration rate.

The natural hydraulic boundary conditions associated with the volcanic mountain ranges that enclose the Valley of Mexico and their relationship

Field 2—WATER CYCLE

Group 2F—Groundwater

to the important aquifers were studied using a two-dimensional, steady-state finite-element model in cross section. Four cross sections were analyzed under hydrologic conditions existing prior to the large scale pumping of the aquifers. Factors such as bulk hydraulic conductivities and regional infiltration rates were obtained from field observations and the literature to assess location of the associated groundwater divides, and the water-table in the mountains. The modeled flow patterns are consistent with the historical hydrologic records, piezometric characteristics and observed surface features of the groundwater in the Basin of Mexico. From the modeling results, the groundwater recharge in the mountains is 30-50% of the mean average precipitation. Higher and lower rates result in a flow regime that is not compatible with field observations. In general the location of the divides in the mountains is displaced towards the Valley of Mexico, which influences the groundwater budget of the Valley. The water table in places is several hundred meters below ground surface, in accordance with field observations of a very thick unsaturated zone. Before major aquifer exploitation began about 50 years ago, 40-50% of the total discharge into the Valley was by upward flow through the lacustrine deposits. The best model results were obtained using a subsurface distribution of hydrostratigraphic units based on recently published geological interpretations. (Author's abstract)
W90-05002

GEOSTATISTICAL MODELLING OF THE WASIA AQUIFER IN CENTRAL SAUDI ARABIA.

King Abdulaziz Univ., Jeddah (Saudi Arabia). Faculty of Earth Sciences.
A. M. Subyani, and Z. Sen.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 295-314, October 1989. 19 fig, 1 tab, 17 ref.

Descriptors: *Geohydrology, *Model studies, *Geochemistry, *Aquifers, *Sedimentary basins, *Computer models, *Saudi Arabia, *Hydrologic models, Spatial distribution, Mapping, Regional analysis, Dissolved solids, Groundwater movement, Flow velocity.

Aquifers in sedimentary basins provide a regional domain for the spatial variabilities in geologic, hydrologic, geomorphologic and hydrochemical phenomena. Their study should account for this spatial variability within the study area prior to any formal modelling. The classical semivariogram models are not capable of accounting for the spatial variability of the Wasia aquifer. A cumulative semivariogram scheme is adopted for spatial variability, which is then incorporated with the kriging technique to provide maps of regional variation concerning variables such as storativity, transmissivity, piezometric levels, total dissolved solids and groundwater flow velocity. Comparison between the cumulative and classical semivariograms are given on the basis of hydrogeologic variables observed in the field. The cumulative semivariogram models for the Wasia aquifer are of the Gaussian type except that of porosity, which has a linear model. The sample cumulative semivariograms are non-decreasing functions of distance and they have every objective advantage of the classical semivariograms. In general, the cumulative semivariogram modelling of the spatial variability is more effective and yields realistic regional variables. (Author's abstract)
W90-05003

PUMPAGE, WATER LEVELS AND RAINFALL IN THREE WELLFIELDS IN WESTERN GALILEE, ISRAEL.

Ministry of Agriculture, Haifa (Israel). Hydrological Service.

B. Azmon.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 369-372, October 1989. 1 fig, 6 ref.

Descriptors: *Groundwater budget, *Hydrologic budget, *Rainfall, *Israel, Aquifers, *Pumpage, *Groundwater level, Regression analysis, Groundwater movement, Boreholes, Wells.

Three wellfields of four boreholes, two related to the Na'aman groundwater basin and the third related to the Kabri groundwater basin in Israel, were evaluated for groundwater flow by multiple linear regression. The dependent variable was the change of hydraulic head and the independent variables were rainfall and pumpage. The change of hydraulic head was tested annually (August-August), for winter (August-April) and for summer (April-August). The test was performed for each borehole as well as for the average of each field. A high correlation was found between the equations of the two variables in which the annual or winter change of hydraulic head was the dependent variable. The two variable regressions can be used to calculate groundwater potential where annual change of hydraulic head is considered to be equal to zero and rainfall is standard. The order of magnitude of groundwater potential of a field was up to 10 mcm, one order of magnitude less than that of the relevant groundwater basins. The storativity was determined independently because the annual change of hydraulic head was not directly measured, but was obtained by means of two variable regressions, which contain parameters of pumping and rainfall. The values of storativity obtained were characteristic for phreatic aquifers. (Author's abstract)
W90-05008

MODEL ANALYSIS OF SEAWATER INTRUSION INTO SATURATED AND UNSATURATED DOMAINS, (IN JAPANESE).

Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.
For primary bibliographic entry see Field 7C.
W90-05053

U.S. GEOLOGICAL SURVEY TOXIC SUBSTANCES HYDROLOGY PROGRAM: PROCEEDINGS OF THE TECHNICAL MEETING, PHOENIX, ARIZONA, SEPTEMBER 26-30, 1988.

For primary bibliographic entry see Field 5B.
W90-05059

SILICA MOBILITY IN A PETROLEUM-CONTAMINATED AQUIFER.

Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W90-05060

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: I. THE DISTRIBUTION OF CHEMICAL SPECIES AND GEOCHEMICAL FACIES.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05061

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: II. EVIDENCE OF ANAEROBIC DEGRADATION OF MONOAROMATIC HYDROCARBONS.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05062

VARIABILITY IN THE CHEMISTRY OF NON-VOLATILE ORGANIC ACIDS DOWNGRADED FROM THE OIL BODY AT BEMIDJI, MINNESOTA.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05063

CHARACTERIZATION OF NONVOLATILE ORGANIC ACIDS RESULTING FROM THE BIODEGRADATION OF CRUDE OIL BY NUCLEAR MAGNETIC RESONANCE SPECTROMETRY.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05064

DETERMINATION OF THE AIR-PHASE PERMEABILITY TENSOR OF AN UNSATURATED ZONE AT THE BEMIDJI, MINNESOTA, RESEARCH SITE.

Geological Survey, West Trenton, NJ.

A. L. Baehr, and M. F. Hult.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 55-62, 3 fig, 1 tab, 10 ref.

Descriptors: *Permeability, *Groundwater movement, *Path of pollutants, *Oil pollution, *Groundwater pollution, *Minnesota, Air-phase permeability, Diffusion, Vapor transport, Biodegradation.

A pneumatic test of an uncontaminated part of the unsaturated zone overlying a glacial outwash aquifer in the vicinity of an oil spill was conducted at the research site in Bemidji, Minnesota, to evaluate vertical and horizontal air-phase permeability simultaneously. A Hantush-type, partially penetrating well solution was adapted from well hydraulics to analyze the pressure data collected during withdrawal of air from a test well. A thin but pneumatically significant lens of silt and fine-grained sand was found to be approximately two orders of magnitude less permeable to air than the medium-grained sand beneath it. The medium-grained sand has a ratio of horizontal to vertical permeability of about 2.5 to 1. Low permeability lenses could affect the distribution of gases in the contaminated region of the unsaturated zone because of vertical heterogeneities in air-phase diffusion constants. This complicates the field testing of hypotheses concerning biodegradation and transport of vapors by use of mathematical models. (See also W90-05059) (Author's abstract)
W90-05065

PRELIMINARY ASSESSMENT OF THE EFFECTS OF ACID MINE DRAINAGE ON GROUND WATER BENEATH A WETLAND NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05072

SPATIAL VARIABILITY OF HYDRAULIC CONDUCTIVITY IN A SAND AND GRAVEL AQUIFER, CAPE COD, MASSACHUSETTS.

Geological Survey, Marlborough, MA.
K. M. Hess, S. H. Wolf, and M. A. Celia.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 143-149, 3 fig, 16 ref.

Descriptors: *Aquifers, *Hydraulic conductivity, *Massachusetts, *Geohydrology, *Groundwater movement, *Cape Cod, Sand, Gravel, Flow measurement, Permeameters, Boreholes, Vertical profiles.

Two methods have been used to obtain detailed vertical profiles of hydraulic conductivity in the sand and gravel aquifer on Cape Cod, Massachusetts—a borehole flowmeter and permeameter analysis of cores. These profiles have been used to define the spatial distribution of hydraulic conductivity in the aquifer. Preliminary statistical analysis of results from flowmeter tests conducted at 10 sites, located along a 22-m-long transect, indicate a geometric mean hydraulic conductivity of 0.097 centimeter/sec, a variance in the natural logarithm of hydraulic conductivity of about 0.24, and best estimates of correlation scales of 0.26 m in the vertical direction and 5.1 m in the horizontal direction. Permeameter results indicate a geometric mean of 0.03 cm/sec, a variance of 0.16, a vertical correlation scale of about 0.3 m and a horizontal correlation scale of approximately 2 m. These correlation scales are statistical indicators of the length over which hydraulic-conductivity measurements are correlated and were determined by fitting exponential models to the results of variogram analyses of the hydraulic-conductivity profiles. Although the mean hydraulic-conductivity

values determined by these two methods differ, the profiles show similar trends with depth in the aquifer. The results of the statistical analysis are being used to test several stochastic theories that relate macrodispersion to the statistical properties of the spatial distribution of hydraulic conductivity within an aquifer. Preliminary calculations indicate a good agreement between the longitudinal dispersivity estimated from these stochastic theories and the dispersivity value observed in a natural-gradient tracer test recently completed at this site. (See also W90-05059) (Author's abstract)
W90-05075

SIMULATION OF THE RATE-CONTROLLED TRANSPORT OF MOLYBDATE IN COLUMN EXPERIMENTS.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05076

SOLUTE DIFFUSION WITHIN SAND OF THE CAPE COD, MASSACHUSETTS, AQUIFER.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05077

USE OF TRACER TESTS TO MEASURE THE TRANSPORT AND CONSUMPTION OF METHANE IN A CONTAMINATED AQUIFER.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05078

INFLUENCE OF GEOCHEMICAL HETEROGENEITY IN A SAND AND GRAVEL AQUIFER ON THE SORPTION OF CHLOROBENZENES.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05079

TRANSPORT OF BACTERIA IN A CONTAMINATED AQUIFER.

Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-05080

FIELD AND LABORATORY STUDIES OF COUPLED FLOW AND CHEMICAL REACTIONS IN THE GROUND-WATER ENVIRONMENT.

Geological Survey, Menlo Park, CA.
J. A. Davis, D. B. Kent, and B. A. Rea.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 189-196, 52 ref.

Descriptors: *Groundwater chemistry, *Water chemistry, *Geochemistry, *Path of pollutants, *Groundwater pollution, *Solute transport, Field tests, Laboratory methods, Model studies, Sorption, Mixing, Dispersion.

A new research effort was developed that emphasizes the use of laboratory and field approaches to understand the principal processes governing the transport of metals that undergo significant chemical reactions in the groundwater environment. The research approach will stimulate the development of transport models that couple the mathematical description of advection and hydrodynamic dispersion with relevant chemical relations for reactive metal ions in groundwaters. Primary objectives include an improved understanding of: (1) the rates of sorption processes and their inclusion in coupled transport models; and (2) the importance of complexation and oxidation-reduction reactions in the transport of solutes. Field studies have shown that the apparent dispersivity of solutes transported in aquifers is much larger than expected from laboratory column tests. Major conclusions of the field tests were that: (1) longitudinal mixing was the dominant dispersion process; (2) transverse horizontal and vertical dispersion were relatively

small; and (3) horizontal displacement of the injected solute cloud was accurately predicted using estimates of the hydraulic conductivity, porosity, and measured hydraulic gradient. The mathematical formulation and solution of coupled transport equations depends considerably on whether the chemical processes can be described by kinetic or equilibrium approaches. The appropriate choice depends on the rates of chemical and physical processes relative to the bulk fluid flow rate and a subjective assessment of the permissible level of error for the model. The research will make significant contributions toward assessing risks arising from industrial, nuclear, and municipal contamination of aquifers. (See also W90-05059) (White-Reimer-PTT)
W90-05081

SITE DESCRIPTION AND SUMMARY OF RESEARCH ACTIVITIES ON THE MOVEMENT AND FATE OF CHLORINATED SOLVENTS IN GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05097

DISTRIBUTION OF TRICHLOROETHENE IN SOIL GAS ABOVE CONTAMINATED GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05099

PRELIMINARY RESULTS OF A STUDY TO SIMULATE TRICHLOROETHYLENE MOVEMENT IN GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05101

BIOTRANSFORMATION OF CHLORINATED HYDROCARBONS AND ALKYL BENZENES IN AQUIFER MATERIAL FROM THE PICATINNY ARSENAL, NEW JERSEY.

Oklahoma Univ., Norman. Environmental and Ground Water Inst.
For primary bibliographic entry see Field 5B.
W90-05103

REGIONAL APPRAISAL OF GROUNDWATER QUALITY IN FIVE DIFFERENT LAND-USE AREAS, LONG ISLAND, NEW YORK.

Geological Survey, Syosset, NY.
For primary bibliographic entry see Field 5B.
W90-05104

OVERVIEW OF THE RELATIONS OF NON-POINT-SOURCE AGRICULTURAL CHEMICAL CONTAMINATION TO LOCAL HYDROGEOLOGIC, SOIL, LAND-USE, AND HYDRO-CHEMICAL CHARACTERISTICS OF THE HIGH PLAINS AQUIFER OF NEBRASKA.

Geological Survey, Lincoln, NE.
For primary bibliographic entry see Field 5B.
W90-05106

RELATIONS BETWEEN LAND USE AND WATER QUALITY IN THE HIGH PLAINS AQUIFER OF SOUTH-CENTRAL KANSAS.

Geological Survey, Lawrence, KS.
For primary bibliographic entry see Field 5B.
W90-05107

ASSESSMENT OF POTENTIAL FOR CONTAMINATION OF THE UPPER FLORIDAN AQUIFER FROM DRAINAGE-WELL RECHARGE IN THE ORLANDO AREA, CENTRAL FLORIDA.

Geological Survey, Orlando, FL.
For primary bibliographic entry see Field 5B.
W90-05110

STATISTICAL COMPARISON OF GROUNDWATER QUALITY IN FOUR LAND-USE AREAS OF STRATIFIED-DRIFT AQUIFERS IN CONNECTICUT.

Geological Survey, Hartford, CT.
For primary bibliographic entry see Field 5B.
W90-05111

METHOD FOR SIMULATING WATER-TABLE ALTITUDES FROM STREAM AND DRAINAGE-BASIN LOCATIONS BY USE OF A GEOGRAPHIC INFORMATION SYSTEM.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7C.
W90-05117

TOTAL ADENYLATE AND ADENYLATE ENERGY-CHARGE MEASUREMENTS FROM BACTERIAL COMMUNITIES IN GROUND WATER.

Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 5A.
W90-05118

PARTITIONING, DISTRIBUTION, AND RECOVERY OF DNA (DEOXYRIBONUCLEIC ACID) FROM WATER AND SEDIMENT IN A CONTAMINATED AQUIFER IN CAPE COD, MASSACHUSETTS.

Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5A.
W90-05119

SOLUBILITY OF ALUMINUM AND IRON IN GROUND WATER NEAR GLOBE, ARIZONA.

Geological Survey, Denver, CO.
K. G. Stollenwerk, and J. H. Eychaner.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. USGS Water-Resources Investigations Report 88-4220, 1989. p581-591, 5 fig, 1 tab.

Descriptors: *Arizona, *Groundwater chemistry, *Aluminum, *Heavy metals, *Acid mine drainage, *Water chemistry, *Geochemistry, *Arizona, *Iron, Model studies, Sulfates, Hydrogen ion concentration, Conductivity, Precipitation, Solubility, Oxidation, Globe.

Identification of a unique set of minerals that can be used to explain the chemical composition of groundwater near Globe, Arizona, is needed so that predictions concerning future changes in solution composition can be made. Geochemical modeling of about 200 groundwater samples indicates that pH and Eh are the predominant variables that ultimately affect the concentration of most solutes, especially metals. Comparisons of ion-activity products calculated for the groundwater samples with thermodynamic equilibrium constants indicate that aluminum solubility may be controlled by precipitation of a basic aluminum sulfate (Al(OH)SO₄) and kaolinite (Al₂Si₂O₅(OH)₄) at pH values less than 4.9. However, the range in ion-activity products for both minerals vary by more than an order of magnitude, indicating that more than one mechanism and/or mineral may control aluminum solubility. At pH values greater than 4.7, microcrystalline gibbsite (Al(OH)₃) is supersaturated and should precipitate. Solubility of iron is affected by pH and redox conditions in the aquifer. Almost all of the iron in solution is in the ferrous oxidation state. Oxidation to ferric iron is limited by the rate of oxygen addition to the aquifer and pH. Once oxidized, ferric iron rapidly precipitates as amorphous ferric hydroxide (Fe(OH)₃). (See also W90-05059) (Author's abstract)
W90-05123

MANGANESE IN CHANNEL SEDIMENTS OF PINAL CREEK, ARIZONA.

Arizona State Univ., Tempe. Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-05124

Field 2—WATER CYCLE

Group 2F—Groundwater

RESEARCH ACTIVITIES RELATED TO ACIDIC WATER NEAR GLOBE, ARIZONA.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 5B.
W90-05125

EFFECTS OF FLY ASH AND FLUE-GAS DESULFURIZATION WASTES ON GROUNDWATER QUALITY IN A RECLAIMED LIGNITE STRIP MINE DISPOSAL SITE.
North Dakota Mining and Mineral Resources Research Inst., Grand Forks.
For primary bibliographic entry see Field 5B.
W90-05131

PROCEEDINGS OF THE ENGINEERING FOUNDATION CONFERENCE: GROUNDWATER CONTAMINATION.
For primary bibliographic entry see Field 5G.
W90-05169

NATIONAL ASSESSMENT OF THE STATE OF GROUNDWATER CONTAMINATION—AN OVERVIEW.
California Univ., Davis. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5B.
W90-05170

DISCIPLINARY AND INTERDISCIPLINARY ASPECTS OF GROUNDWATER QUALITY MANAGEMENT: A LAWYER'S PERSPECTIVE.
For primary bibliographic entry see Field 5G.
W90-05171

IMPACTS, COSTS, AND TECHNIQUES FOR MITIGATION OF CONTAMINATED GROUNDWATER: A REVIEW.
Resources for the Future, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W90-05172

GROUNDWATER QUALITY MANAGEMENT: THE SEARCH FOR A LEGAL-INSTITUTIONAL FRAMEWORK.
For primary bibliographic entry see Field 5G.
W90-05173

FRAMEWORK FOR FUTURE PREVENTION AND MANAGEMENT OF GROUNDWATER CONTAMINATION.
Arizona Univ., Tucson. Dept. of Political Science.
For primary bibliographic entry see Field 5G.
W90-05174

EPA GROUND WATER PROTECTION STRATEGY.
Environmental Protection Agency, San Francisco, CA. Region IX.
For primary bibliographic entry see Field 5G.
W90-05175

LOCAL GOVERNMENT AND GROUNDWATER QUALITY MANAGEMENT.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W90-05176

NATIONAL POLICY FOR GROUNDWATER PROTECTION: DOES ONE EXIST.
Virginia Water Resources Research Center, Blacksburg.
For primary bibliographic entry see Field 5G.
W90-05177

RISK ASSESSMENT FOR GROUNDWATER CONTAMINATION.
Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
For primary bibliographic entry see Field 5G.
W90-05178

GROUNDWATER HEALTH RISK ASSESSMENT: A CASE STUDY.
California Univ., Los Angeles. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5C.
W90-05179

MODELING CONTAMINANT TRANSPORT IN GROUNDWATER: APPROACHES, CURRENT STATUS, AND NEEDS FOR FURTHER RESEARCH AND DEVELOPMENT.
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 5B.
W90-05180

MOBILITY OF COLLOIDAL PARTICLES IN THE SUBSURFACE: CHEMISTRY AND HYDROLOGY OF COLLOID-AQUIFER INTERACTIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W90-05184

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS 1984-87.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05187

HYDROLOGIC EVALUATION AND WATER SUPPLY CONSIDERATIONS FOR FIVE PAIUTE INDIAN LAND PARCELS, MILLARD, SEVIER, AND IRON COUNTIES, SOUTHWESTERN UTAH.
Geological Survey, Salt Lake City, UT. Water Resources Div.
D. Price, D. W. Stephens, and L. S. Conroy.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4010, 1989. 39p, 13 fig, 3 tab, 31 ref.

Descriptors: *Utah, *Groundwater, *Water resources data, *Surface water, *Water supply, Potential water supply.

The hydrologic resources in and adjacent to five parcels of land held in trust for the Paiute Indian Tribe of Utah were evaluated. The land, located in southwestern Utah, is generally arid and has had only limited use for grazing. The parcels are located near the towns of Cove Fort, Joseph, Koo-sharem, and Kanarraville. On the basis of available geohydrologic and hydrologic data, water of suitable quality is locally available in the areas of all parcels for domestic, stock, recreation, and limited irrigation use. Developing this water for use on the parcels would potentially involve obtaining water rights, drilling wells, and constructing diversion structures. Surface water apparently is the most favorable source of supply available for the Joseph parcel, and groundwater apparently is the most favorable source of supply available for the other parcels. (USGS)
W90-05189

GEOHYDROLOGY OF THE FOOTHILL GROUNDWATER BASIN NEAR SANTA BARBARA, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Freckleton.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4017, 1989. 46p, 21 fig, 8 tab, 26 ref.

Descriptors: *Water pollution sources, *Groundwater pollution, *Unconsolidated aquifers, *Geohydrology, *California, *Groundwater movement, Recharge, Pumpage, Mathematical models, Santa Barbara.

Geohydrologic data presented in this report indicate that the East Subbasin of the Goleta groundwater basin and Storage Unit II of the Santa Barbara groundwater basin should be considered as a separate groundwater basin, which is referred to as the Foothill groundwater basin in this report. The 4.5 sq-mi Foothill groundwater basin is bordered on the north and northeast by the Santa Ynez Mountains and on three sides by faults that impede groundwater flow. Sedimentary rocks of Tertiary age underlie the groundwater basin and form its lower boundary. Unconsolidated deposits of the Santa Barbara Formation (Pliocene and Pleistocene age) form the principal aquifer of the basin. Where a zone of low permeability separates it from overlying Quaternary alluvium, the aquifer is confined. In the early 1950's, groundwater levels declined more than 60 ft during periods of heavy pumping. From the mid-1950's to the late 1970's, groundwater levels generally rose. Water levels during 1984-87 generally declined. Nitrate concentrations in samples from two wells exceeded the primary maximum contaminant level established by the U.S. Environmental Protection Agency. Secondary maximum contaminant levels for dissolved solids, chloride, and sulfate also were exceeded in some samples. A three-dimensional finite-difference model was developed for part of Foothill groundwater basin. Steady-state verification and transient-state model calibrations were used to estimate or confirm estimates of basin recharge and natural discharge. (USGS)
W90-05194

EVALUATION AND MODELING OF VOLATILE ORGANIC VAPOR TRANSPORT IN THE UNSATURATED ZONE FOR GROUNDWATER QUALITY PROTECTIONS.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5B.
W90-05200

PREDICTION OF GROUNDWATER FLOW AND MASS TRANSPORT USING LINEAR AND NONLINEAR ESTIMATION METHODS.
Stanford Univ., CA. Dept. of Civil Engineering. P. K. Kitanidis.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119603/AS. Price codes: A09 in paper copy, A02 in microfiche. Final Report, August 1989. 191p, 27 ref, 5 append. USGS Contract 14-08-0001-G1491. USGS Project G1491.

Descriptors: *Groundwater flow, *Diffusion, *Fourier analysis, *Model studies, *Mass transport, *Prediction, *Estimating, Water pollution, Head gradients, Path of pollutants, Transmissivity, Hydraulic conductivity, Mathematical models.

Geologic formations are heterogeneous with respect to the properties which affect groundwater flow and transport. However, the reliability of predictions can be improved through the effective use of site-specific measurements, descriptions of the spatial structure of geohydrologic properties, and mathematical models of flow and transport. Past research has focused on methods which involve some form of linearization and consequently are applicable to small-variance cases. The applicability of this approach was evaluated through analysis and applications. A refinement was advanced, founded on the linearization of the governing equations about the best estimates given all available measurements. This methodology is advantageous when the variance of the logarithm of conductivity is large but there are many measurements. Furthermore, this research has combined analytical and numerical methods to extend such methods to large-variability cases. Among other contributions, numerical spectral methods were advanced for the derivation of the distribution of head given the distribution of the hydraulic conductivity or transmissivity. Another contribution was the development of an approach for the estimation of head gradients. The developed methodologies can be used by modelers in calculating probabilities needed in risk analysis, in selecting sampling strategies, in assessing the degree of contamination, and

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in devising cost effective and reliable management policies. (USGS)
W90-05201

GROUND-WATER AND SURFACE-WATER DATA FOR WASHINGTON COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 7C.
W90-05207

WATER RESOURCES AND ESTIMATED EFFECTS OF GROUNDWATER DEVELOPMENT, CECIL COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2E.
W90-05208

APPRAISAL OF GROUND-WATER QUALITY IN THE BUNKER HILL BASIN OF SAN BERNARDINO VALLEY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.
L. F. W. Duell, and R. A. Schroeder.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4203, Sept. 1989. 69p, 14 fig, 9 tab, 18 ref.

Descriptors: *Water pollution sources, *California, *Groundwater pollution, *Water quality, *Nitrates, *San Bernardino Valley, Organic solvents, Fluorides, Dissolved solids, Land use, Aquifer management, Bunker Hill Basin.

Water samples were collected from 47 wells and analyzed for concentration of major inorganic ions, nitrogen species, and volatile (purgable) organic priority pollutants to assess groundwater quality in the Bunker Hill basin, California. Data were supplemented with additional analysis of nitrate, tetrachloroethylene, and trichloroethylene made by other agencies. The organic quality of groundwater in the basin generally is suitable for most uses, although fluoride concentration exceeded the California public drinking water standard of 1.4 mg/L in water from 5 of 47 wells. Nitrate (as nitrogen) concentration equaled or exceeded the public drinking water standard of 10 mg/L in water from 13 of 47 wells sampled for this study and in an additional 19 of 120 samples analyzed by other agencies. Concentration generally decreased with increasing depth below land surface. Twenty-four of the 33 volatile organic priority pollutants were detected in water from wells sampled during this study. When supplemental data from other agencies are included, tetrachloroethylene concentration exceeded the standard of 5 micrograms/L in water from 49 of 128 wells. No basinwide relation between contamination by these two chemicals and well depth or land use was discerned. A network of 11 observation wells that could be sampled twice a year would enhance the monitoring of changes groundwater quality in the Bunker Hill basin. (USGS)
W90-05211

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN TEXAS—FISCAL YEAR 1988.

Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05213

COMPILATION OF GEOHYDROLOGIC DATA COLLECTED AS PART OF THE AREAL APPRAISAL OF GROUND-WATER RESOURCES NEAR BRANSON, MISSOURI.

Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05216

ANALYSIS OF THE EFFECT OF PUMPING ON GROUND-WATER FLOW IN THE SPRINGFIELD PLATEAU AND OZARK AQUIFERS NEAR SPRINGFIELD, MISSOURI.

Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4079, Oct. 1989. 63p, 31 fig, 3 tab, 23 ref.

Descriptors: *Groundwater mining, *Drawdown, *Missouri, *Springfield Plateau, *Ozark Aquifer, *Groundwater, Wells, Geohydrology, Hydrologic budget, Model studies, Water use.

Pumpage of water from the Ozark aquifer for public supply and industry use by the city of Springfield and surrounding communities in southwestern Missouri has significantly altered the potentiometric surface of the aquifer. Springfield is located on a regional groundwater divide that trends east and west across southern Missouri. Groundwater that once flowed north and south from the divide now moves toward Springfield. Drawdown in the Ozark aquifer beneath Springfield has increased about 50 ft near the center of the city since 1974. The area of well influence also has increased, most notably to the south and southwest, because of increased pumpage by Springfield and new groundwater withdrawals in rapidly increasing communities, such as Republic and Nixa. Changes in the potentiometric surface of the Ozark aquifer, and to a lesser extent the Springfield Plateau aquifer, resulting from stresses applied by pumpage of water supply wells has altered the hydrologic budget of the Springfield area. Downward leakage of groundwater through the Ozark confining unit has increased from about 10 cu ft/sec to about 18 cu ft/sec because drawdown in the Ozark aquifer has resulted in an increased vertical hydraulic gradient across the confining unit. Minimal quantities of water are supplied by increased upward leakage through the St. Francois confining unit. Model simulations indicate substantial quantities of water are still (1987) being removed from storage within the Ozark and Springfield Plateau aquifers and the hydrologic system is not in equilibrium at this time. (USGS)
W90-05218

HYDROLOGIC EFFECTS OF PUMPAGE FROM THE DENVER BASIN BEDROCK AQUIFERS OF NORTHERN EL PASO COUNTY, COLORADO.

Geological Survey, Denver, CO. Water Resources Div.
E. R. Banta.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4033, October 1989. 84p, 55 fig, 5 plates, 13 tab, 22 ref.

Descriptors: *Groundwater, *Model studies, *Drawdown, *Water level fluctuations, *Denver basin, *Colorado, Computer models.

The Denver groundwater basin underlies a 6,700 sq-mi area in eastern Colorado. To assess current conditions of the four bedrock aquifers in the basin, water levels, streamflow gain and loss, and other data were collected. Current aquifer conditions in the southern part of the basin and likely response to various 100-year pumping scenarios were analyzed using a digital finite-difference model. Simulated predevelopment flow through the bedrock aquifers was about 59 cu ft/sec. Water level changes between 1978 and 1985, likely caused by variations in precipitation and in pumping and by lowering of the water table in the overlying Black Squirrel Creek alluvial aquifer, ranged from rises of more than 40 ft to declines of as much as 80 ft. In 1985, pumping from the bedrock aquifers was about 56 cu ft/sec. Simulations indicate that 43% of the pumpage came from a decrease in volume of groundwater in storage; 37% came from induced recharge and captured discharge. The remaining 20% came from a transient high rate of recharge from precipitation. A baseline 10-yr simulation, beginning in 1985, indicated minimal drawdowns for constant pumping at 1985 rates in the southern part of the basin. Other simulations indicated that the pumpage required to supply the needs of the projected population would be accompanied by drawdowns of as much as 1,300 ft and by large

decreases in amount of groundwater in storage. Pumpage from a hypothetical well field, located where the aquifers are thickest, and from the aquifers underlying Colorado Springs also was simulated. (USGS)
W90-05219

WATER-LEVEL CHANGES IN THE HIGH PLAINS AQUIFER UNDERLYING PARTS OF SOUTH DAKOTA, WYOMING, NEBRASKA, COLORADO, KANSAS, NEW MEXICO, OKLAHOMA, AND TEXAS—PREDEVELOPMENT THROUGH NONIRRIGATION SEASON 1987-88.

Geological Survey, Denver, CO. Water Resources Div.
W. M. Kastner, D. E. Schild, and D. S. Spahr.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4073, October 1989. 61p, 28 fig, 2 tab, 21 ref.

Descriptors: *Selective withdrawal, *Water table, *High Plains, *Drawdown, *Water level, Water use, Water demand.

The changes in water levels in the High Plains aquifer from the nonirrigation season 1986-87 through the nonirrigation season 1987-88 and from the nonirrigation season 1979-80 through the nonirrigation season 1987-88 are presented in maps for the entire High Plains aquifer area. Water level changes are caused by interacting changes in precipitation, land use, and annual pumpage. Water levels declined from conditions prior to development until 1980 through parts of the High Plains of Nebraska, Colorado, New Mexico, Oklahoma, and Texas. From 1980 through 1987 water level changes were mixed, with declines of more than 10 ft in the highly developed areas of Kansas, New Mexico, Oklahoma, and Texas and relatively stable to rising water tables throughout the remaining aquifer area. The net change was a rise of 0.8 ft. The 1981-87 period was generally wetter than normal and pumping for irrigated agriculture was therefore reduced. Water level changes were mixed during 1987. Declines continued in some highly developed areas, but water levels generally rose throughout most of the aquifer. The average area-weighted change was a rise of 0.28 ft. This rise was due to the generally greater than normal precipitation, decreased acreage under irrigation, and decreased pumpage for those areas irrigated. At the end of the growing season, the drought in the Midwest in 1988 affected only limited areas of the High Plains. The effects of the drought on water levels can not be assessed until the water-level measurements for the nonirrigation season of 1988-89 are compiled. (USGS)
W90-05220

NUMERICAL SOLUTION FOR THE DIFFUSION EQUATION IN HYDROGEOLOGIC SYSTEMS.

Geological Survey, Urbana, IL. Water Resources Div.

A. L. Ishii, R. W. Healy, and R. G. Striegl.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4027, 1989. 94p, 8 fig, 5 tab, 22 ref.

Descriptors: *Diffusion coefficient, *Differential equations, *Finite difference methods, *Mathematical models, *Aeration zone, Fortran, Groundwater, Natural gas, Temperature gradient.

The documentation of a computer code for the numerical solution of the linear diffusion equation in one or two dimensions in Cartesian or cylindrical coordinates is presented. Applications of the program include molecular diffusion, heat conduction, and fluid flow in confined systems. The flow media may be anisotropic and heterogeneous. The model is formulated by replacing the continuous linear diffusion equation by discrete finite-difference approximations at each node in a block-centered grid. The resulting matrix equation is solved by the method of preconditioned conjugate gradients. The conjugate gradient method does not re-

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quire the estimation of iteration parameters and is guaranteed convergent in the absence of rounding error. The matrices are preconditioned to decrease the steps to convergence. The model allows the specification of any number of boundary conditions for any number of stress periods, and the output of a summary table for selected nodes showing flux and the concentration of the flux quantity for each time step. The model is written in a modular format for ease of modification. The model was verified by comparison of numerical and analytical solutions for cases of molecular diffusion, two-dimensional heat transfer, and axisymmetric radial saturated fluid flow. Application of the model to a hypothetical two-dimensional field situation of gas diffusion in the unsaturated zone is demonstrated. The input and output files are included as a check on program installation. The definition of variables, input requirements, flow chart, and program listing are included in the attachments. (USGS)
W90-05222

GROUNDWATER INVESTIGATION OF SO4(2-) DIFFUSION FROM A CRETACEOUS SHALE HILLSLOPE: UPPER COLORADO RIVER BASIN.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5B.
W90-05234

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1985.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05235

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1984.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05236

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1984.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05237

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1984.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05238

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1985.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05239

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1983.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05240

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1984.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05241

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1985.

Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05242

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05243

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05244

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05245

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1984.
Geological Survey, Jacksonville, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05246

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984. VOLUME 1, HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05249

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984. VOLUME 2, COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05250

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1985. VOLUME 1, HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05251

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1984.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05252

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1984.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05253

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984. VOLUME 1, ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 7C.

W90-05254

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984. VOLUME 2, DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05255

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985. VOLUME 1, ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7C.
W90-05256

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985. VOLUME 2, DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7C.
W90-05257

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1984.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05258

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1985.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05259

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1987.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05262

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 2, LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05263

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 3, WESTERN NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05264

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1988. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05265

HYDROLOGIC DATA COLLECTED IN THE VICINITY OF THE PROPOSED GAMMA-RAY AND NEUTRINO DETECTOR SITE, HOT SPRING COUNTY, ARKANSAS, 1988-89.
Geological Survey, Little Rock, AR. Water Resources Div.
D. J. Fitzpatrick, and P. W. Westerfield.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-623, January 1990. 17p, 4 fig.

Descriptors: *Hydrologic data, *Groundwater, *Water resources data, *Water quality, *Precipitation, *Streamflow, *Acid mine drainage, *Arkansas, Hot Spring County.

An abandoned barite mine in Hot Spring County, Arkansas, has been selected as the location for a proposed gamma-ray and neutrino detector site. As part of the hydrologic evaluation of the site, the U.S. Geological Survey in cooperation with the Arkansas Geological Commission collected hydrologic data at selected locations in the vicinity of the abandoned barite mine. Data collected as part of the project included water quality, pond-evaluation, and precipitation data within the abandoned barite mine and flow and water quality data at selected sites in the vicinity of the mine. Water quality samples from within the abandoned mine were collected at three locations in the pond at selected depths. These data included field measurements of specific conductance, pH, water temperature, dissolved oxygen, major ions, and trace metals. Major ion and trace-metal samples were collected at six stream sites, one lake site, and two wastewater pond sites. Pond elevation and precipitation data from within the abandoned barite mine were measured during the period between July 1, 1988 and June 30, 1989. Twelve discharge measurements during the period between June 21, 1988, and June 26, 1989, were collected at six sites in the vicinity of the abandoned barite mine. (USGS) W90-05268

WATER RESOURCE OF SEDGWICK COUNTY, KANSAS.

Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05270

WATER RESOURCES OF SOLEDAD, POWAY, AND MOOSA BASINS, SAN DIEGO COUNTY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 5D.
W90-05274

FRESHWATER WITHDRAWALS AND WATER-USE TRENDS IN FLORIDA, 1985.

Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 6D.
W90-05279

SELECTED WATER-QUALITY CHARACTERISTICS AND FLOW OF GROUNDWATER IN THE SAN LUIS BASIN, INCLUDING THE CONEJOS RIVER SUBBASIN, COLORADO AND NEW MEXICO.

Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-05280

SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN COLORADO—FISCAL YEAR 1989.

Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05281

HYDROLOGIC AND CHEMICAL DATA FOR SELECTED THERMAL-WATER WELLS AND SPRINGS IN THE INDIAN BATHTUB AREA, OWYHEE COUNTY, SOUTHWESTERN IDAHO.

Geological Survey, Boise, ID. Water Resources Div.
H. W. Young, and D. J. Parlman.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-589, 1989. 19p, 4 fig, 3 tab.

Descriptors: *Geochemistry, *Geohydrology, *Surface-groundwater relations, *Groundwater,

*Hot springs, *Thermal water, *Idaho, Well data, Well hydrographs, Stable isotopes, Water quality discharge hydrographs, Indian Bathtub Spring.

This report presents data collected during January through September 1989 from 86 thermal-water wells and 5 springs in the Indian Bathtub area, southwestern Idaho. The data include well and spring locations, well-construction and water level information, hydrographs of water levels in 9 wells, hydrographs of discharges in 4 springs, and chemical and isotopic analysis of water from 33 thermal-water wells and 5 springs. These data were collected as part of a continuing study to determine the cause or causes of decreased discharge at Indian Bathtub Spring and other thermal springs along Hot Creek. (USGS) W90-05282

AQUIFER TESTS IN THE FLOOD-PLAIN ALLUVIUM AND SANTA FE GROUP AT THE RIO GRANDE NEAR CANUTILLO, EL PASO COUNTY, TEXAS.

Geological Survey, Albuquerque, NM. Water Resources Div.
E. L. Nickerson.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4011, 1989. 30p, 11 fig, 1 tab, 21 ref.

Descriptors: *Geohydrology, *Water resources data, *Aquifer testing, *Surface-groundwater relations, *Texas, Aquifer characteristics, Hydraulic properties, Transmissivity, Storage coefficient, Permeability coefficient, Unconfined aquifers, Leaky aquifers, Confined aquifers, Mesilla Valley, El Paso County.

An aquifer system consisting of the Rio Grande flood-plain alluvium and Santa Fe Group underlying the southern Mesilla Valley in Dona Ana County, New Mexico and El Paso County, Texas has become an important source of water for both municipal and agricultural uses. Determination of aquifer properties is essential in order to evaluate groundwater potential for increasing water demand and potential streamflow depletion of the Rio Grande due to groundwater development. The aquifer system at the Canutillo well field hydrologic section was divided into a shallow, intermediate, and deep zone based on geohydrologic characteristics. Aquifer properties of specific zones at the test site were determined from a series of multiple-well aquifer tests conducted from December 3, 1985 through January 20, 1986. The Rio Grande is hydraulically connected to the shallow flood-plain alluvium. Water generally occurs within the shallow zone under unconfined conditions, within the intermediate zone under semiconfined conditions, and within the deep zone under confined conditions. (USGS) W90-05283

GAC ADSORPTION AND INFRARED REACTIVATION: A CASE STUDY.

Jefferson Parish Dept. of Water, LA.
W. E. Koffsky, and B. W. Lykins.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 1, p. 48-56, January 1990. 10 fig, 8 tab, 6 ref.

Descriptors: *Water treatment, *Water treatment facilities, *Activated carbon, Case studies, Costs, Organic carbon, Organic halides, Louisiana.

The effectiveness and cost of removing trace organic contaminants and surrogates from drinking water by granular activated carbon (GAC) adsorption was evaluated. The effect of multiple reactivations of spent GAC was also evaluated. Results indicated that reactivated GAC effluent was essentially equivalent to that of virgin GAC when total organic carbon or total organic halides were evaluated. Although low levels of some reactivation by-products were observed, the maximum associated risk level was only 3 in 1,000,000,000. A capital investment of approximately \$2.2 million (in 1983 dollars) was required for design and construction of the 3-mgd GAC adsorption and reactivation facility. The operations and maintenance cost for

this facility was projected to be approximately \$0.14/1,000 gal for a 20-min empty bed contact time and a three-month reactivation cycle. (Author's abstract) W90-05290

EVALUATING THE ONDA MASS TRANSFER CORRELATION FOR THE DESIGN OF PACKED-COLUMN AIR STRIPPING.

Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. Staudinger, W. R. Knocke, and C. W. Randall.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 1, p. 73-79, January 1990. 2 fig, 4 tab, 34 ref.

Descriptors: *Water treatment, *Air stripping, *Volatile organic compounds, Model studies, Mass transfer rate, Packed columns, Temperature, Interactions.

A crucial parameter for predictive modeling of the performance of packed columns is the mass transfer rate. An initial screening identified the Onda mass transfer correlation as the most promising predictive model available. The study described here sought to quantify the accuracy that can be expected with the Onda correlation, based on a test data base that was established using 10 literature-reported, pilot-scale investigations and that involved 11 different volatile organic chemicals and 4 basic packing types. The correlation predicted the transfer rate constants within an average standard deviation of 17 percent (437 data points), corresponding to a plus or minus 30 percent accuracy value for design purposes based on 90 percent confidence limits. The model adequately handled the following specific areas of concern identified in the evaluation: (1) specific compound effects (interactions and concentration levels); (2) gas-phase resistance predictions; (3) performance differences between distinct packing configurations; (4) extreme column operating conditions; and (5) temperature effects. (Author's abstract) W90-05293

HYDROLOGY, COMMUNITY STRUCTURE, AND PRODUCTIVITY PATTERNS OF A DISTROPHIC CAROLINA BAY WETLAND.

Emory Univ., Atlanta, GA. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05357

TOWARDS A BIOLOGICAL AND CHEMICAL DEFINITION OF THE HYPORHEIC ZONE IN TWO CANADIAN RIVERS.

Toronto Univ. (Ontario). Div. of Life Sciences.
D. D. Williams.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p. 189-208, October 1989. 7 fig, 6 tab, 27 ref. Natural Sciences and Engineering Council of Canada.

Descriptors: *Aquatic life, *Ontario, *Aquatic habitats, *Ecological distribution, *Chemical stratification, Interfaces, Geohydrology, Correlation analysis, Chemical analysis, Crustaceans, Midge, Oligochaetes.

A series of samples of interstitial water and fauna was taken along transects, extending from the channel into the bank, in two small rivers in southern Ontario, Canada. These were examined for any discontinuities which might indicate the position of the hyporheic/groundwater interface. Several chemical discontinuities in Duffin Creek, with 'break' lines occurring from the river margin obliquely downwards under the bank for dissolved oxygen and carbon dioxide, biochemical oxygen demand (BOD), alkalinity, suspended solids and amount of organic matter, were found. Break lines in nitrate and sulfide concentration ran obliquely from near the margin, down to under the river bed. In the Rouge River, a discontinuity extending obliquely from a point approximately 1.5 m landwards from the margin to down under the river was indicated by dissolved carbon dioxide, B.O.D., conductivity, suspended solids, organic matter, nitrate and alkalinity. Ordination (DECORANA) and community classification (TWINSPAN) re-

Field 2—WATER CYCLE

Group 2F—Groundwater

vealed that linear distance from mid-river was the major factor associated with community structure in both rivers. The community under the bank was also distinct from the river community in both rivers and these two communities were separated by another community characteristic of the river margin. In Duffin Creek, the classification procedure additionally discriminated surface and interstitial sub-sets within the river community. Most taxa showed no significant correlations with the chemistry of the interstitial water, but the densities of the copepod *Diatylops crassicaudus brachycercus* (Kiefer) and *Oligochaeta* were positively correlated with nitrate and worms were also negatively correlated with sulfide in Duffin Creek. In the Rouge River, nematode density was positively correlated with sulfide concentrations. The hyporheic faunas of these two rivers were dominated by insects, particularly chironomids. Compared with the hyporheos of rivers in Europe and Colorado, the two Ontario rivers lack significant numbers of harpacticoid copepods as well as bathynellid, amphipod and isopod crustaceans. (Author's abstract)

W90-05358

BACKGROUND CONCENTRATION RANGES OF HEAVY METALS IN SWEDISH GROUNDWATERS FROM CRYSTALLINE ROCKS: A REVIEW

Linköping Univ. (Sweden). Dept. of Water and Environmental Research.

For primary bibliographic entry see Field 2K.
W90-05413

LYSIMETER EXPERIMENTS ON THE CORRELATION OF THE INCREASE OF NITRATE CONCENTRATION AND HARDNESS IN GROUNDWATER (LYSIMETERVERSUCHE UEBER DEN ZUSAMMENHANG DES ANSTIEGES DER NITRATKONZENTRATION UND DER HAERTE IM GRUNDWASSER).

Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Radiochemie.

For primary bibliographic entry see Field 5B.
W90-05423

DOCUMENTATION OF A COMPUTER PROGRAM TO SIMULATE STREAM-AQUIFER RELATIONS USING A MODULAR, FINITE-DIFFERENCE, GROUND-WATER FLOW MODEL.

Geological Survey, Carson City, NV. Water Resources Div.

For primary bibliographic entry see Field 2A.
W90-05548

GROUND-WATER CONTAMINATION AT AN INACTIVE COAL AND OIL GASIFICATION PLANT SITE, GAS WORKS PARK, SEATTLE, WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 5B.
W90-05550

USE OF TEMPERATURE PROFILES BE NEATH STREAMS TO DETERMINE RATES OF VERTICAL GROUND-WATER FLOW AND VERTICAL HYDRAULIC CONDUCTIVITY.

For primary bibliographic entry see Field 2A.
W90-05554

DEVELOPMENT OF A CAPILLARY WICK UNSATURATED ZONE PORE WATER SAMPLER.

Texas Agricultural Experiment Station, College Station.

For primary bibliographic entry see Field 7B.
W90-05556

HYDROGEOLOGY AND SIMULATED EFFECTS OF GROUND-WATER DEVELOPMENT OF THE FLORIDAN AQUIFER SYSTEM, SOUTHWEST GEORGIA, NORTHWEST FLORIDA, AND SOUTHERNMOST ALABAMA.

Geological Survey, Doraville, GA. Water Resources Div.

sources Div.

M. L. Maslia, and L. R. Hayes.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Professional Paper 1403-H, 1988. 71pp, 29 fig, 8 tab, 24 plates, 60 ref.

Descriptors: *Geohydrology, *Water resources development, *Model studies, *Water table decline, *Groundwater potential, *Simulation analysis, *Floridan Aquifer, *Georgia, *Florida, *Alabama, Hydrologic models, Finite difference methods, Groundwater mining, Groundwater recharge.

The Floridan aquifer system underlies parts of South Carolina, Georgia, and Alabama and all of Florida. Two areas have experienced increases in groundwater withdrawals from the Floridan aquifer system: the Dougherty Plain in SW Georgia and the Fort Walton Beach area of northwest Florida. In SW Georgia, the Floridan aquifer system is overlain by sandy clay residuum that has an average thickness of approximately 50 ft and was derived from the chemical weathering of the Ocala Limestone. In the western panhandle of Florida, the aquifer is overlain by the Pensacola Clay, which varies in thickness from 50 to 450 ft. Mean annual precipitation is about 51 and 63 inches, respectively, in the Dougherty Plain area of SW Georgia and in northwest Florida. Because the Floridan aquifer system is thinly covered in SW Georgia, during September to May stream-flow and groundwater levels are directly correlated with precipitation. Three two-dimensional finite difference numerical models--the subregional flow model, the Dougherty Plain flow model, and the Fort Walton Beach flow model--were developed to simulate groundwater flow in the Floridan aquifer system in the study area. The subregional flow model is intended to simulate the major features of the flow system. The detailed Dougherty Plain and Fort Walton Beach flow models are intended to simulate the effects of groundwater development in these areas. Simulation of a consecutive 3-yr hydrologic drought in SW Georgia, with total pumpage of 339 billion gallons, resulted in a mean water level decline of 26 ft. In some areas, water levels declined from a few feet to as much as 10 ft below the top of the Upper Floridan aquifer. Pumpage of 1,224 billion gallons resulted in mean water level declines of 33 ft. Simulated declines in the year 2000 for the Upper Floridan aquifer ranged from 40-60 ft in Fort Walton Beach and from 20-30 ft in Destin, Valparaiso, Niceville, and Mary Esther. (Lantz-PTT)

W90-05562

MONITORING FOR VOLATILE ORGANICS IN EFFERVESCENT GROUND WATER.

Du Pont de Nemours (E.I.) and Co., Aiken, SC.

Savannah River Plant.

For primary bibliographic entry see Field 5A.
W90-05581

PROGRAM PLAN: TESTING OF VACUUM EXTRACTION AND IN-SITU AIR STRIPPING TECHNOLOGIES.

Savannah River Lab., Aiken, SC. Technical Div.

For primary bibliographic entry see Field 5G.
W90-05582

GROUND-WATER MONITORING COMPLIANCE PROJECT FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988.

Battelle Pacific Northwest Labs., Richland, WA.

For primary bibliographic entry see Field 5A.
W90-05585

GEOHYDROLOGY AND WATER QUALITY IN THE VICINITY OF THE GETTYSBURG NATIONAL MILITARY PARK AND EISENHOWER NATIONAL HISTORIC SITE, PENNSYLVANIA.

Geological Survey, Harrisburg, PA. Water Resources Div.

A. E. Becher.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Water-Resources Investigations Report 89-4154, 1989. 44p, 10 fig, 6 tab, 25 ref.

Descriptors: *Geohydrology, *Groundwater quality, *Gettysburg National Military Park, Pennsylvania, Wells, Organic compounds, Pesticides, Calcium, Drinking water, Magnesium, Bicarbonates, Iron, Manganese, Heavy metals, Nitrates, Aquifers.

Wells in the Gettysburg National Military Park, Eisenhower National Historic Site, and Gettysburg Borough supply drinking water to the park staff and, annually, more than 1 million visitors. A network of about 60 wells was established to measure water levels and sample groundwater. Water levels were measured continuously in five wells and synchronously in the larger network during spring and fall of 1986. Shale, siltstone, and sandstone of the Gettysburg Formation, intruded by a 2,000-ft-thick diabase sill in the southeastern part of the area, form the bedrock framework. Two vertical diabase dikes extend northward and form barriers to groundwater flow in the Gettysburg Formation. In the Gettysburg Formation, the shallow aquifer is connected to deep, discontinuous, tabular aquifers in beds prone to fracturing. Groundwater flow tends to be anisotropic parallel to the strike of bedding both in the shallow and deep aquifers of the Gettysburg Formation. Pumping affects water levels in wells > 2,500 ft apart along strike. Calcium, Mg, and bicarbonate are the dominant constituents in the groundwater. Concentrations of dissolved solids are about 40% greater in water from the Gettysburg Formation than water from the diabase. Concentrations of nontoxic elements, Fe and Mn, slightly exceed US EPA secondary maximum contaminant levels in 4 of 21 samples. No concentration of the toxic trace elements As, Ba, Ca, Cr, Pb, Se, or Hg exceeds the maximum contaminant levels (MCLs) established by the US EPA. A nitrate concentration of excess of the US EPA MCL of 10 mg/L was found only in water from one well. Pesticides were present, at nontoxic concentrations (near minimum detection limits) in water from five wells, two of which are currently (1987) in use. Trichloroethylene (TCE) and tetrachloroethylene (PCE) were the dominant purgeable organic compounds (POC) detected. No POC were present in park wells above concentrations of 1 micrograms/L, and, no concentration exceeded US EPA MCLs. POC were detected only in water from wells that are approximately aligned, and in a zone parallel to strike that extends into areas of known groundwater contamination and/or production wells. (Lantz-PTT)

W90-05592

SELECTED WATER-QUALITY CHARACTERISTICS AND FLOW OF GROUND WATER IN THE SAN LUIS BASIN, INCLUDING THE CONEJOS RIVER SUBBASIN, COLORADO AND NEW MEXICO.

Geological Survey, Denver, CO. Water Resources Div.

R. S. Williams, and S. E. Hammond.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4040, 1989. 43p, 12 fig, 5 tab, 1 plate, 18 ref.

Descriptors: *Geochemistry, *Groundwater quality, *Groundwater movement, *Hydrologic data collections, San Luis River Basin, Conejos River Basin, Chemical analysis, Colorado, New Mexico, Wells, Springs, Dissolved solids, Calcium, Sodium, Sodium bicarbonate, Calcium bicarbonate.

Chemical analyses of water from 99 wells and 19 springs in the San Luis basin in Colorado and New Mexico were evaluated to determine selected water quality characteristics as an aid in understanding the flow of groundwater in the basin. The evaluation shows that the distribution of chemical water types in the basin is consistent with chemical changes to be expected along flow paths in rocks typical of those in the basin. The San Luis basin area is underlain by a surficial (< 100-ft-thick) unconfined aquifer and, in turn, by a confining bed and a deeper confined aquifer. Previous studies have indicated that the groundwater system is recharged around the edges of the basin and that

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groundwater then moves toward discharge areas in the topographically closed part of the basin and along principal streams. The evaluation of water quality data showed that groundwater at the perimeter of the San Luis basin is primarily a calcium bicarbonate type, which is typical in recharge areas. Groundwater near the center of the basin is primarily a sodium bicarbonate type, which is typical of groundwater in downgradient areas. The change in principal cation from calcium to sodium indicates chemical evolution of the water along the groundwater flow path and supports previously developed concepts of groundwater movement in the basin. The exchange of calcium for sodium along the flow path also is assumed to occur in the Conejos River subbasin. Upgradient wells yield calcium bicarbonate type water, whereas downgradient wells yield sodium bicarbonate type water. However, an exception to this relation is found at McIntire Spring, which yields calcium bicarbonate type water from a downgradient location. The source of water discharging from the spring may be the confined aquifer, with hydraulic connection along the Manassa fault. The concentration of dissolved solids in water from both the unconfined and confined aquifers increases downgradient. The increase is dramatic in the closed basin, ranging from < 500 mg/L to > 30,000 mg/L. In this area, the normal increase in concentration by dissolution of minerals along the flow path is exceeded by the increase due to evapotranspiration from the shallow water table. (Lantz-PTT)
W90-05593

PROCEDURE FOR EVALUATING OBSERVATION-WELL NETWORKS IN WYOMING, AND APPLICATION TO NORTHEASTERN WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7A.
W90-05597

HYDROLOGY OF THE CASTLE LAKE BLOCKAGE, MOUNT ST. HELENS, WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-05599

HYDROLOGY OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER, SOUTH-CENTRAL UNITED STATES—A PRELIMINARY ASSESSMENT OF THE REGIONAL FLOW SYSTEM.

Geological Survey, Little Rock, AR. Water Resources Div.
D. J. Ackerman.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4028, 1989. 74p, 40 fig, 5 tab, 37 ref.

Descriptors: *Geohydrology, *Mississippi River, *Alluvial aquifers, *Groundwater movement, Flow pattern, Aquifers, Hydrology, Geohydrology, Finite difference methods, Hydraulic conductivity, Gulf of Mexico Coastal Plain, Groundwater recharge.

The Mississippi River Valley alluvial aquifer is a part of the Mississippi Embayment aquifer system in the Gulf of Mexico Coastal Plain. The alluvial aquifer is prolific; groundwater withdrawals from it totaled 7,600 cu ft/sec in 1985, mostly for irrigation of rice, and accounted for nearly 60% of all groundwater pumpage in the Gulf Coastal area. A three-layer finite difference model was constructed and calibrated to simulate two-dimensional steady-state regional confined or unconfined flow. Calibration values of geohydrologic properties were achieved by adjusting hydraulic conductivities of each of the three layers (the confining unit, the alluvial aquifer, and underlying units) and of the riverbed materials to minimize the root-mean-squared error of observed head and simulated head for 1972 data. Calibrated values of conductivity are as follows: (1) hydraulic conductivity of the alluvial aquifer, 300 ft/day; (2) vertical hydraulic con-

ductivity of the confining unit, 0.0003 ft/day; (3) ratio of vertical hydraulic conductivity to bed thickness for riverbed materials, 0.05/day; and (4) ratio of vertical hydraulic conductivity to bed thickness for underlying units three times that used by the Mississippi embayment and Cretaceous and Paleozoic subregional models. The 1972 groundwater flow system, listed in order of the magnitude of net changes from predevelopment, is summarized as follows: (1) pumpage from the alluvial aquifer for irrigation has caused regional flow to move toward pumping centers (depressions in the potentiometric surface), (2) discharge to rivers decreased, (3) recharge from rivers increased, (4) recharge from the confining unit increased, (5) discharge to underlying aquifers increased, and (6) recharge from underlying aquifers decreased. In 1972, recharge from the Mississippi River Valley confining unit averaged 0.8 in/yr for the alluvial aquifer. Drawdown > 20 ft occurred primarily at two locations in Arkansas—the Grand Prairie region and the area west of Crowley's Ridge. (Lantz-PTT)
W90-05603

GEOHYDROLOGY AND GROUND-WATER QUALITY AT SELECTED SITES IN MEADE COUNTY, KENTUCKY, 1987-88.

Geological Survey, Louisville, KY. Water Resources Div.
D. S. Mull, A. G. Alexander, and P. E. Schultz.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4108, 1989. 67p, 5 fig, 8 tab, 57 ref.

Descriptors: *Water quality, *Karst, *Geohydrology, *Groundwater quality, *Meade County, Coliforms, Kentucky, Drinking water, Bacteria, Dissolved solids, Fluorides, Lead, Wells, Springs, Organic compounds.

Meade County in north-central Kentucky is about 305 sq mi in size, and is underlain by thick beds of limestone and dolomite which are the principal sources of drinking water for about 8,500 residents. About half the area contains mature, karst terrain with abundant sinkholes, springs, and caves. Because of this karst terrain, groundwater is susceptible to rapid changes in water quality and contamination from human sources. Thirty-seven wells and 12 springs were selected as sampling points to characterize groundwater quality in the area. Water was analyzed for major anions and cations, nitrates, trace elements, and organic compounds. Water from selected sites was also analyzed for fecal species of coliform streptococci bacteria and total coliform content. Except for fluoride and lead, the water quality was within the range expected for carbonate aquifers. The fluoride content was significantly higher in water from wells than in water from springs. Concentrations of detectable lead ranged from 10 to 50 micrograms/L and had a median value of 7.5 microg/L. Dissolved solids ranged from 100 to 2,200 mg/L and the median value was 512 mg/L. Hardness ranged from 20 to 1,100 mg/L and the median value was 290 mg/L. Organic compounds detected by the gas chromatographic/flame ionization detection scans, did not indicate evidence of concentrations in excess of the current Federal drinking water standards. Analysis for specific organic compounds indicated that the presence of these compounds was associated with agricultural chemicals, usually pesticides. Total coliform content exceeded drinking water standards in water from all 12 springs and in 18 wells. Statistical analysis of the groundwater quality data indicates that the variance of the concentrations of fluoride and chloride may be attributed to the site type. There was strong correlation between hardness and dissolved solids, hardness and sulfate, and sulfate and dissolved solids. No apparent relations were detected between water quality and the geographic location of sampling sites. However, seasonal variations were detected in the concentrations of dissolved solids, hardness, and iron. (Lantz-PTT)
W90-05604

WATER RESOURCES OF SEDGWICK COUNTY, KANSAS.

Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05605

YIELD AND QUALITY OF GROUND WATER FROM STRATIFIED-DRIFT AQUIFERS, TAUNTON RIVER BASIN, MASSACHUSETTS: EXECUTIVE SUMMARY.

Geological Survey, Boston, MA. Water Resources Div.
W. W. Lapham, and J. C. Olimpio.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 86-4053A, 1989. 11p, 2 fig, 3 tab, 37 ref.

Descriptors: *Water demand, *Groundwater resources, *Groundwater quality, *Stratified aquifers, *Massachusetts, *Taunton River Basin, *Pollutant identification, Heavy metals, Organic compounds, Iron, Manganese, Dichloroethane, Dichloroethylene, Toluene, Trichloroethane, Chloroethane, Chloroform, Standards.

Water shortages are a chronic problem in parts of the Taunton River basin and are caused by a combination of factors. Water use in this part of the Boston metropolitan area is likely to increase during the next decade. The Massachusetts Division of Water Resources projects that about 50% of the cities and towns within and on the perimeter of the basin may have water supply deficits by 1990 if water management projects are not pursued throughout the 1980s. Estimates of the long-term yield of the 26 regional aquifers indicate that the yields of the two most productive aquifers equal or exceed 11.9 and 11.3 cu ft/sec, 90% of the time, respectively, if minimum stream discharge is maintained at 99.5% flow duration. Eighteen of the 26 aquifers were pumped for public water supply during 1983. Further analysis of the yield characteristics of these 18 aquifers indicates that the 1983 pumping rate of each of these 18 aquifers can be sustained at least 70% of the time. Selected physical properties and concentrations of major chemical constituents in groundwater from the stratified-drift aquifers at 80 sampling sites were used to characterize general water quality in aquifers throughout the basin. The pH of the groundwater ranged from 5.4 to 7.0. Natural elevated concentrations of Fe and Mn in water in the stratified-drift aquifers are present locally in the basin. Natural concentrations of these two metals commonly exceed the limits of 0.3 mg/L for Fe and 0.05 mg/L for Mn recommended for drinking water. Fifty-one analyses of selected trace metals in groundwater samples from stratified-drift aquifers throughout the basin were used to characterize trace metal concentrations in the groundwater. Of the 10 constituents sampled that have US EPA limits recommended for drinking water, only the Pb concentration in water at one site (60 micrograms/L) exceeded the recommended limit of 50 micrograms/L. Analyses of selected organic compounds in water in the stratified-drift aquifers at 74 locations revealed that 13 of the sample contained one or more of the following compounds: chloroform; carbon tetrachloride; dichloroethane; dichloroethylene; tetrachloroethylene; and, toluene. (Lantz-PTT)
W90-05615

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.

Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 5G.
W90-05618

2G. Water In Soils

APPLICATION OF FRACTAL MATHEMATICS TO SOIL WATER RETENTION ESTIMATION. Nevada Univ., Las Vegas. Desert Research Inst.
For primary bibliographic entry see Field 7C.
W90-04614

Field 2—WATER CYCLE

Group 2G—Water In Soils

MODELING THE TRANSPORT OF CHROMIUM (VI) IN SOIL COLUMNS.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-04615

ALUMINUM PRECIPITATION AND DISSOLUTION RATES IN SPODOSOL BS HORIZONS IN THE NORTHEASTERN USA.
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-04618

ROLE OF FUNGI IN STABILIZING AGGREGATES OF SEWAGE SLUDGE AMENDED SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 5E.
W90-04621

CLASSIFYING SOILS FOR ACIDIC DEPOSITION AQUATIC EFFECTS: A SCHEME FOR THE NORTHEAST USA.
Corvallis Environmental Research Lab., OR.
For primary bibliographic entry see Field 5B.
W90-04622

ANTECEDENT RAINFALL AND TILLAGE EFFECTS ON INFILTRATION.
Minnesota Univ., St. Paul. Dept. of Soil Science.
D. M. Freebairn, S. C. Gupta, C. A. Onstad, and W. J. Rawls.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1183-1189, July/August 1989. 6 fig, 3 tab, 24 ref.

Descriptors: *Infiltration, *Soil absorption capacity, *Tillage, *Rainfall infiltration, *Agricultural runoff, *Soil moisture retention, Rainfall simulators, Agricultural hydrology, Soil horizons, Soil properties, Leaching, Water pollution sources.

Infiltration characteristics of a Port Byron (fine-silt, mixed, mesic, Typic Hapludoll) silt loam soil located in the karst terrain of southeastern Minnesota were determined using both ponded water and simulated rainfall. Three tillage treatments, with and without surface cover, were studied to provide a range of soil physical conditions. Simulated rainfall was applied after various amounts of both natural and artificial rain had fallen since tillage. Large differences in infiltration characteristics were attributed to the development of a surface crust. In the absence of a crust, this soil was highly permeable ($> 200 \text{ mm/h}$) while surface-crusted infiltration rates were as low as 10 mm/h . Statistical analysis showed that $> 77\%$ of variation in infiltration rate, Green and Ampt hydraulic conductivity, and curve number was explained by the depth of rainfall since tillage, surface cover, and random roughness. Microrelief roughness probably maintains higher infiltration rates due to increased ponding depth and greater hydraulic gradient, while maintaining a higher conductivity as a result of discontinuities in the developing surface crust. Assuming that soil stability is not influenced by tillage history in the short term (1-2 yr), it is likely that reduced disruption of crusts associated with reduced tillage practices could increase the opportunity for movement of surface-applied chemicals in runoff water while decreasing leaching because of reduced infiltration capacity. (Friedmann-PTT) W90-04624

WATER RELATIONSHIPS OF CLAYPAN AND CONSTRUCTED SOIL PROFILES.
Agricultural Research Service, Temple, TX.
V. L. Hauser, and F. W. Chichester.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1189-1196, July/August 1989. 13 fig, 3 tab, 15 ref.

Descriptors: *Land reclamation, *Mine wastes, *Clays, *Soil physical properties, *Rainfall infiltration, *Soil profiles, *Strip mine wastes, *Soil moisture retention, Soil surfaces, Hardpan soils, Soil water, Infiltration rate.

Claypan soils with poor physical properties are the only surface materials available to cover and reclaim much of the spoil left by strip mining for coal in east-central Texas. An undisturbed claypan soil profile of Axtell fine sand loam (fine montmorillonitic, thermic Udic Paleustalfs) was compared to four constructed soil profiles; these were evaluated as cover soils for toxic minespoil. Profiles constructed from minespoil selected for low pyrite content alone (non-topsoiled) was compared against the same selected spoil covered by a mixture of Axtell soil material. The rainfall intake rate and physical properties of the materials controlled forage production by kleingrass (*Panicum coloratum* L.). All of the constructed soils stored less water in the soil profile than the undisturbed claypan soil, and forage yield was reduced on them during drought. Infiltration rate during the first 2 cm of rainfall influenced forage yield more than final intake rate. Mulch application increased water storage and forage yield up to 15% on selected minespoil, but not on the mixed claypan soil profiles. Either selected minespoil or a mixture of Axtell soil may be used to cover toxic random soil with a nontoxic layer, but the Axtell mix had the least acid-forming potential. Selected minespoil material was equal in value to a mixture of the 1.8 m claypan soil profile as a surface material for constructed minespoils. (Author's abstract) W90-04625

MOISTURE AND NUTRIENT STATUS OF EXTREMELY ACID UMBREPTS IN THE BLACK MOUNTAINS OF NORTH CAROLINA.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
D. D. Richter, K. S. King, and J. A. Witter.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1222-1228, July/August 1989. 4 fig, 5 tab, 40 ref.

Descriptors: *Soil organic matter, *Soil water, *Soil moisture retention, *Soil-water-plant relationships, *Soil physical properties, *Acidic soils, Cycling nutrients, Soil properties, Minerals, Soil chemistry.

Moisture and nutrient conditions are poorly characterized in soils at elevations $> 1500 \text{ m}$ in the southern Appalachian Mountains. In the Black Mountains, high elevation soils are Typic and Lithic Haplumbrepts, with umbric epipedons that are extremely acid, organic-rich, rocky, and unstable due to the steep slopes. Many of the Umbrepts in the Black Mountains have been disturbed by exploitative logging, repeated wildfires, and depredation by the balsam woolly adelgid (*Adelges piceae* Ratzeburg), each of which has caused major fluctuations in C, nutrient, and hydrologic cycles of soils and ecosystems. A study was conducted to evaluate predictions based on climate, forest disturbance, and soil genesis that: (1) these soils are rarely subjected to low water potential; (2) soil N mineralization rates are currently high; and (3) availability of soil nutrient cations is low. A water balance model appropriate for soils with average water-holding characteristics indicated that, on a 6-yr recurrence interval, plants deplete soil moisture to $< -0.2 \text{ MPa}$ during low rainfall periods of one-month duration. High rock contents (about 0.40 cu m/cu m of soil volume in 40-cm depth) limit soil water storage capacity, and make the spruce-fir forests very dependent on regular rainfall supplies. Soil N appears mineralizable at moderately high rates, as indicated by three soil and plant indices of N availability, whereas plant availability of Ca and Mg appears marginal. Exchangeable Ca and Mg total only 6.4 and 3.4 kmol/ha, respectively, in the surface 40 cm of mineral soil, low contents that indicate rapid rates of biogeochemical cycling of divalent cations in these ecosystems. The long-term recovery of these soils from 20th century disturbances depends directly on the dynamics of soil organic matter, due to the susceptibility of the organic matter to disturbance and to its control over soil moisture and nutrient availability. (Author's abstract) W90-04627

SIMULATION OF SOIL WATER ABOVE A WATER TABLE IN A FORESTED SPODOSOL.

International Paper Co., Arkadelphia, AR.
L. P. Phillips, N. B. Comerford, D. G. Neary, and R. S. Mansell.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1236-1241, July/August 1989. 5 fig, 3 tab, 18 ref.

Descriptors: *Model studies, *Soil water, *Forest hydrology, *Water table, *Soil water potential, Aeration zone, Capillary zone, Soil horizons, Rainfall infiltration, Sand, Forest hydrology.

The relationships between soil water potential and water table depth in the upper five horizons of an Ultic Hapludol of the lower Coastal Plain flatwoods are described. Soil water pressure head in the E, Bh, Bs, and E' horizons was in hydrostatic equilibrium with the underlying water table during all conditions when water was perched above an argillic horizon. The A horizon was in equilibrium with the water tables only when water tables were < 65 to 70 cm from the soil surface. Water pressure heads and contents in the soil profile were simulated using a finite-difference, one-dimensional, unsaturated water-flow model. Simulations of water pressure head were excellent for the lower horizons (E through E') under all conditions, and poor for the A horizon. During high water tables, water pressure head simulations for the A horizon were improved. Fewer discrepancies between measured and simulated conditions occur when water pressure head values are converted to volumetric water contents. The water-flow model used did not adequately handle high infiltration rate rainfall events experienced at the site. It is concluded that in these sandy soils: (1) water content is the preferred prediction variable; and (2) further advances in mechanistically modeling water uptake from each soil horizon in forest ecosystems will be limited by adequate information on plant root biology. (Author's abstract) W90-04628

SOIL NITROGEN CHANGES DURING PRIMARY SUCCESSION ON A FLOODPLAIN IN ALASKA, U.S.A.
Alaska Univ., Fairbanks. Arctic Environmental Engineering Lab.
L. R. Walker.

Arctic and Alpine Research ATLPAV, Vol. 21, No. 4, p 341-349, November 1989. 1 fig, 4 tab, 44 ref.

Descriptors: *Flood plains, *Sedimentation, *Forest soils, *Soil chemistry, *Alluvium, *Nitrogen, *Flooding, *Vegetation establishment, *Subarctic zone, Alaska, Succession, Nitrogen fixation.

Surface soil nitrogen changes along a subarctic vegetation chronosequence on a floodplain in central Alaska resulted from interactions between stochastic flooding and the influence of vegetation. River alluvium initially contributed 400 kg/ha of nitrogen to the top 200 mm of time-zero soils. Subsequent nitrogen accumulations were in part due to nitrogen fixers such as alder (*Alnus tenuifolia*). Kjeldahl nitrogen levels reached 1696 kg/ha in surface mineral soils of 30-yr-old alder stands. Extractable forms of nitrogen also increased 4-fold in 30 yr. However, soil nitrogen increases also resulted from frequent floods that deposited additional nitrogen-rich alluvium. Frequently flooded low terraces had high silt content and relatively high nitrogen levels. Frequent flooding of some forested upper terraces resulted in poorer development of forest floors, higher sand content, and dilution of nitrogen levels compared with upper terraces that were less often flooded. Although nitrogen levels were primarily determined by biotic factors, periodic flooding and associated changes in particle size also affected concentration and pool sizes of nitrogen in soils of the vegetation chronosequence. (Author's abstract) W90-04639

ANALYTICAL SOLUTION OF A CONVECTION-DISPERSION MODEL WITH TIME-DEPENDENT TRANSPORT COEFFICIENTS.
Western Australia Univ., Nedlands. Centre for

Water Research.
For primary bibliographic entry see Field 5B.
W90-04658

USE OF REMOTELY SENSED SOIL MOISTURE CONTENT AS BOUNDARY CONDITIONS IN SOIL-ATMOSPHERE WATER TRANSPORT MODELING: 1. FIELD VALIDATION OF A WATER FLOW MODEL.
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol. H. Witono, and L. Bruckler.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2423-2435, December 1989. 18 fig, 2 tab, 30 ref.

Descriptors: *Water pressure, *Soil water, *Soil temperature, *Boundary conditions, *Hydraulic conductivity, *Remote sensing, Moisture tension, Soil water potential, Thermal conductivity, Mathematical models.

A physically based heat and mass flow model is presented and compared with experimental data measured on a bare soil (27.2% clay, 61.7% silt, 11.0% sand) under field conditions. Both liquid and vapor phases were taken into account, and soil temperature and water pressure head were the descriptive variables. The model was directly driven by soil surface temperature and water pressure head (derived from moisture content), which were used as boundary conditions. Coupled equations were solved using a numerical finite element method, from the soil surface to 1-m depth. The experiment was conducted on a bare soil (0.1 ha) for a 7-day period. The period was dry for 5 days (calibration phase) and then rainy (validation phase). Soil water balance was determined from gravimetric water content, neutron probe profiles, and tensiometer measurements. The unsaturated hydraulic conductivity/volumetric water content relationship was measured under field conditions, and the apparent thermal conductivity/water content relationship was derived from the thermal profile analysis. The proposed model described soil temperature and water content variations vs. time quite well. After a calibration phase, differences between the measured and calculated temperatures and volumetric water contents were below 1.5 degrees and 0.03 cu m/cu m, respectively. Analysis of the errors involved in both initial and soil surface boundary conditions showed that these errors induced moderate effects on actual evaporation calculations. Although the vapor phase contributed largely to the total water fluxes, differences between coupled heat and water transport or isothermal liquid phase models were very small in regard to the actual evaporation or infiltration estimates. This was explained by the use of soil surface moisture content as boundary conditions which induced increasing soil surface pressure head gradients when the simplified isothermal liquid phase water flow model was used. (See also W90-04661) (Author's abstract)
W90-04660

USE OF REMOTELY SENSED SOIL MOISTURE CONTENT AS BOUNDARY CONDITIONS IN SOIL-ATMOSPHERE WATER TRANSPORT MODELING: 2. ESTIMATING SOIL WATER BALANCE.
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol. L. Bruckler, and H. Witono.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2437-2447, December 1989. 10 fig, 3 tab, 16 ref.

Descriptors: *Soil water, *Soil temperature, *Hydraulic conductivity, *Remote sensing, Mathematical models, Boundary conditions, Hydrological budget.

A previously calibrated soil/atmosphere heat and water transport model was used to analyze (1) errors involved in soil water balance estimates under drying periods when soil surface moisture contents derived from microwave measurements were used as soil surface boundary conditions, and (2) consequences of time periods separating two consecutive soil boundary conditions under evapo-

ration or infiltration conditions on soil water balance calculations. Soil moisture and dry bulk density measurements were performed on a 0.4-ha bare field (27.2% clay, 61.7% fine and coarse loam) with simultaneous measurements of backscattering coefficients (5.3 GHz, HH polarization, 15 degrees incidence angle). Regression lines between backscattering coefficient and volumetric water content were calculated taking into account different soil depths. Two methods for estimating soil surface moisture contents were proposed. In the first one, moisture contents for an arbitrary soil depth were directly extracted from a single 'backscattering coefficient/water content' calibration line. The second method combined several calibration lines relative to several arbitrary soil depths. Results showed that (1) under drying periods (5 days) the methods led generally to moderately biased or unbiased water balances, (2) both errors due to the backscattering coefficient measurements and calibration line parameters had little effect on water balance estimations (< or = 10%), and (3) under evaporation conditions (5 days) or combined evaporation and infiltration phases (15 days), numerous soil surface boundary conditions vs. time should be available to avoid wrong water balance estimates. Under evaporation conditions, one soil surface moisture content per day appeared satisfactory when it corresponded to the mean daily soil surface moisture content. Under combined evaporation and infiltration conditions, results depended strongly on the precise position of water content boundary conditions vs. time, connected with rainfall sequences. (See also W90-04660) (Author's abstract)
W90-04661

SIMULATION OF THREE-DIMENSIONAL FLOW OF IMMISCIBLE FLUIDS WITHIN AND BELOW THE UNSATURATED ZONE.
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5B.
W90-04662

FIELD-SCALE TRANSPORT OF INTERACTING SOLUTES THROUGH THE UNSATURATED ZONE: 1. ANALYSIS OF THE SPATIAL VARIABILITY OF THE TRANSPORT PROPERTIES.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
D. Russo.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2475-2485, December 1989. 12 fig, 1 tab, 42 ref.

Descriptors: *Path of pollutants, *Unsaturated flow, *Solute transport, *Soil physics, *Soil water, Hydraulic conductivity, Sodium, Calcium, Aeration zone, Chlorides.

The effect of physicochemical interactions between the soil solution and the soil matrix on the spatial variability of soil properties pertinent to the transport of mixed Na/Ca-Cl salts in the unsaturated zone was analyzed. These properties were the soil hydraulic conductivity and the soil water retention functions and the retardation and the elution factors which account for Na/Ca exchange and Cl exclusion. On the local scale, effects of the soil solution concentration and composition (in terms of the Cl concentration C and the Na adsorption ratio SAR, respectively) on these soil properties were derived using a theoretical approach which combined the mixed-ion diffuse double layer theory, the structure of the clay particles, the soil's pore size distribution, and hydrodynamic principles. On the field scale the effect of the soil solution C and SAR on these soil properties was analyzed by coupling the theoretical approach with measured spatial distributions of the soil hydraulic properties at a reference 'inert' state as well as of the soil cation exchange capacity and the soil specific surface area. The effect of the soil solution-soil matrix interactions on the spatial variability of the soil hydraulic properties and the retardation and the elution factors was quantified in terms of mean values and coefficients of variation, expressed as functions of the soil solution C and SAR, and the degree of effective saturation. For given values of SAR and C the effect of soil

solution-soil matrix interactions on the spatial variability of the hydraulic properties decreases as the effective saturation decreases. The converse is true in the case of the retardation and the elution factors. The most significant conclusion is that for a considerable range of soil solution concentration and composition, and degree of water saturation which is relevant to most of the irrigated fields in arid and semiarid zones, the spatial distributions of the transport properties may vary with both the salinity and the water content of the field. (See also W90-04665) (Author's abstract)
W90-04664

FIELD-SCALE TRANSPORT OF INTERACTING SOLUTES THROUGH THE UNSATURATED ZONE: 2. ANALYSIS OF THE SPATIAL VARIABILITY OF THE FIELD RESPONSE.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
D. Russo.

Water Resources Research WRERAQ, Vol. 25, No. 12, p 2487-2495, December 1989. 4 fig, 1 tab, 19 ref.

Descriptors: *Unsaturated flow, *Path of pollutants, *Solute transport, *Soil physics, *Soil water, Hydraulic conductivity, Sodium, Calcium, Chlorides, Aeration zone.

The effect of physicochemical interactions between the soil solution and the soil matrix on the spatial variability of the soil-dependent variables during transient transport of mixed Na/Ca-Cl salts through the unsaturated zone of a large field-scale soil is analyzed. The spatial variability of the soil water and solute transport properties were used as inputs to a conceptual stochastic model describing one-dimensional vertical transport of water and soil-interacting solutes through the unsaturated zone of a spatially variable soil, viewed as a collection of vertically homogeneous and independent soil columns. Using data of the spatial distributions of pertinent soil properties from the Bet Dagan field, the transport process was simulated for boundary and initial conditions pertinent to the application of low-salinity and low-alkalinity waters (rain) to the surface of a saline-alkaline soil, considering effects of the soil solution concentration and composition on the soil water and solute transport properties. The spatial variability (in terms of field averages and coefficients of variation) of the profiles of the soil water content, the Cl concentration, and the Na adsorption ratio of the soil solution and the soil hydraulic conductivity at given elapsed times were presented and compared with those evaluated from simulations of the same boundary value problem where the effect of the soil solution concentration and composition on the water and solute transport properties was disregarded. Results suggested that because of soil solution-soil matrix interactions the field-average movement of both the water and the solutes may be retarded and their spatial variability may be increased relative to the case where these interactions had not been considered. In the Bet Dagan field, after 5 hours of continuous filtration, the field averages of the positions of the wetting front and the Cl front were retarded by 10 and 15%, respectively; the relative variabilities of the positions of these fronts were increased by 16 and 38%, respectively; and the equivalent effective dispersivity was increased by 18%, relative to the reference inert case. (See also W90-04664) (Author's abstract)
W90-04665

STOCHASTIC ANALYSIS OF FIELD MEASURED UNSATURATED HYDRAULIC CONDUCTIVITY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. Unlu, M. L. Kavvas, and D. R. Nielsen.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2511-2519, December 1989. 9 fig, 2 tab, 16 ref.

Descriptors: *Hydraulic conductivity, *Soil physics, *Soil water, *Unsaturated flow, *Stochastic models, Spatial variability, Statistical analysis.

Field 2—WATER CYCLE

Group 2G—Water in Soils

Unsaturated hydraulic conductivity (K) values as a function of soil-water pressure head (h) were measured in the soil at 75 cm depth at 70 different sites separated from one another by a distance of 1 m along a horizontal transect. K field was viewed as a random function of spatial location (x). Field data were analyzed (1) to examine the isotropy and stationarity of K, (2) to check the ergodicity of K in the mean and covariance functions, and (3) to characterize the distribution properties of K by estimating the higher-order correlations, i.e., third and fourth cumulants. The mean functions were estimated by averaging over h and x. The covariance function was studied to investigate its spatial origin dependency. Logs and square roots of K were used for estimating the third and fourth cumulants. Results showed that spatial covariance functions are anisotropic and both lag and origin dependent, i.e., spatially nonhomogeneous. Because the stationarity (statistical homogeneity) of K is scale dependent, which was indicated by the identification of locally stationary covariance regions, the ergodic properties of K are also scale dependent at smaller spatial scales. Results related to the distribution characteristics of K indicated that although ln K is marginally Gaussian distributed, in the context of spatial stochastic processes the random field of ln K is not Gaussian because the third and fourth cumulants of the field are still significantly different from zero and have the same order of magnitude as the first and second cumulants. The square root transformation, however, resulted in a random field that is approximately Gaussian although marginal distributions of the square root of K remained skewed. Analyses of ln K and the square root of K indicated that better transformations which would result in both marginal and joint Gaussian behavior for the random field of K are needed. (Author's abstract)
W90-04668

EFFECT OF ORGANOCHLORINE COMPOUNDS ON EXISTENCE AND GROWTH OF SOIL ORGANISMS.
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 5C.
W90-04796

IRRIGATION SCHEDULING MODEL WITH GROUNDWATER AND LIMITED ROOTING.
Ahmadu Bello Univ., Zaria (Nigeria). Inst. for Agricultural Research, Irrigation Research Program.
For primary bibliographic entry see Field 3F.
W90-04816

EVIDENCE FOR COOXIDATION OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SOIL.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W90-04833

DISTRIBUTION OF TRICHLOROETHYLENE IN SOIL GAS ABOVE CONTAMINATED GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.
Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05099

MICROBIOLOGICAL TRANSFORMATION OF TRICHLOROETHYLENE IN SOIL AT PICATINNY ARSENAL, NEW JERSEY.
Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5B.
W90-05100

DISTRIBUTION OF MAJOR AND TRACE ELEMENTS IN CORE SAMPLES FROM PICATINNY ARSENAL, NEW JERSEY.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05102

USE OF A SIMPLIFIED TRANSPORT MODEL FOR PESTICIDES IN THE UNSATURATED ZONE.
Geological Survey, Richmond, VA.
For primary bibliographic entry see Field 5B.
W90-05116

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS 1984-87.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05187

MOVEMENT OF PESTICIDES AND NUTRIENTS INTO TILE DRAINAGE WATER.
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-05232

DEVELOPMENT OF A CAPILLARY WICK UNSATURATED ZONE PORE WATER SAMPLER.
Texas Agricultural Experiment Station, College Station.
For primary bibliographic entry see Field 7B.
W90-05556

2H. Lakes

PLAYA LAKES: PRAIRIE WETLANDS OF THE SOUTHERN HIGH PLAINS.
North Carolina Univ. at Wilmington.
E. G. Bolen, L. M. Smith, and H. L. Schramm.
Bioscience BSNAS, Vol. 39, No. 9, p 615-623, October 1989. 3 fig, 86 ref.

Descriptors: *Playa lakes, *Limnology, *Playas, *Lakes, *Prairies, *Great Plains, *Ephemeral lakes, *Irrigation effects, Water loss, Catchment areas, Aquatic habitats, Aquatic populations, Texas, New Mexico.

Playas are shallow, circular basins dotting the surface of plains and desert landscapes. Nowhere are they more numerous or as dense as on the Southern High Plains, a 82,000-sq km. tableland south of the Canadian River in Texas and New Mexico. The faunal and cultural histories, and the regional climatology and hydrology of these playas are reviewed. The climate of the Southern High Plains (SHP) varies from semi-arid in the north and west of warm-temperate in the east and dry steppe in the south. No permanent rivers or streams cross the SHP. Except for irrigation runoff, surface water draining into the playas largely results from precipitation. Water loss from the playas that are not used for irrigation results from seepage and evaporation. Water volumes in playas vary seasonally. The value of playas, in general, may lie in the diversity of the vegetation and thus, the associated fauna. The development and economic importance of playas is related largely to agricultural production, and playas are grazed, cropped, and modified with pits for irrigation. Cultivation alters playas by converting wetlands to croplands, and making modifications to facilitate their drainage or utility for irrigation. Reduction of the vegetated buffer surrounding playa lakes can affect water quality. The deeper and relatively stable water-level conditions are conducive to the development of anoxic conditions in the sediments, and nutrient cycling thus may be retarded. Livestock grazing and feedlot effluent affect playas. Grazing, by reducing plant cover, increases runoff into playas and favors shorebird use of playa habitats. Excessive or continuous grazing, however, will eliminate desirable cover for several kinds of wildlife. (Friedmann-PTT)
W90-04555

DEAD SEA SURFACE-LEVEL CHANGES.
Weizmann Inst. of Science, Rehovoth (Israel).
Dept. of Isotope Research.
D. A. Anati, and S. Shasha.

Israel Journal of Earth Sciences IJERAK, Vol. 38, No. 1, p 29-32, 1989. 2 fig, 1 tab, 3 ref.

Descriptors: *Saline lakes, *Evaporation, *Water use, *Water resources development, *Lakes, *Dead Sea, *Water level, *Water level fluctuations, Falling stage, Water depth, Israel.

It is shown that during the period 1981-1988, the year-to-year variations in the surface level of the Dead Sea were not very large and, therefore the average rate of level drop for the period is quite meaningful. The surface-level changes in the near future are then estimated assuming this rate were to stay constant. It was determined that the rate of level drop of the Dead Sea surface during the study period has been 0.8 ± 1 m/y. If climatic conditions and the extent of human intervention remain at the present state, by the year 2011 the level will have dropped to minus 425 m. (Friedmann-PTT)
W90-04555

MEIOFAUNAL RESPONSES TO SEDIMENTATION FROM AN ALASKAN SPRING BLOOM: I. MAJOR TAXA.
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
J. W. Fleeger, T. C. Shirley, and D. A. Ziemann.
Marine Ecology Progress Series MESED, Vol. 57, No. 2, p 137-145, October 5, 1989. 5 fig, 1 tab, 48 ref. NOAA contract NA-85-ABH-022.

Descriptors: *Estuaries, *Algal blooms, *Biomass, *Phytoplankton, *Algae, *Sedimentation, *Ecological effects, *Population density, Aquatic plants, Aquatic animals, Aquatic habitats, Chlorophyll, Auke Bay, Alaska.

Metazoan meiofaunal community dynamics and spring phytoplankton bloom sedimentation rates were measured concurrently in Auke Bay, Alaska, from 1985 to 1988. The null hypothesis, that recruitment and density maxima are unrelated to sedimentation events, was tested. Springtime chlorophyll a sedimentation was predictable and episodic, occurring annually at peak rates during mid-May at 35 m; carbon sedimentation was continuous through the spring. Cumulative sedimentation varied from year to year, ranging from lowest to highest by a factor of 2. At a 30 m station, seasonal variation in major taxon density was not identifiable, however interannual variations in meiofaunal densities did occur. No consistent relationship between meiofaunal abundances and spring chlorophyll a or carbon sedimentation was found, i.e., years with the highest or lowest nematode and harpacticoid abundances did not correspond to years with the highest or lowest values for sedimentation. Other factors must regulate interannual variation in meiofauna, at least over the range of values for sedimentation in Auke Bay. (Author's abstract)
W90-04609

DIET VARIATION IN A SHALLOW TROPICAL BRAZILIAN LAKE: II. PRIMARY PRODUCTION, PHOTOSYNTHETIC EFFICIENCY AND CHLOROPHYLL-A CONTENT.
Universidade Federal de Minas Gerais, Belo Horizonte (Brazil). Dept. of General Biology.
F. A. R. Barbosa, J. G. Tundisi, and R. Henry.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 4, p 435-448, 1989. 5 fig, 2 tab, 30 ref.

Descriptors: *Lake stages, *Primary productivity, *Photosynthesis, *Limnology, *Chlorophyll a, *Phytoplankton, *Diurnal variation, Stratification, Water temperature, Light penetration, Lake Carioca, Brazil.

Diel variations of phytoplankton primary production, photosynthetic efficiency and chlorophyll-a concentration were studied in three periods of the year—early stratification (September 1979), maximum stratification (February 1980) and mixing (July 1980)—at one central station of Lake Carioca, Eastern Brazil. Comparisons between in situ and simulated primary production measurements suggested an endogenous rhythm in the photosynthet-

ic activity of the phytoplankton. This and the diel variation in the underwater light climate and temperature condition are suggested to entrain/maintain the observed diurnal variations of the primary production. Diel variations also affect a deep chlorophyll maximum during the period of maximum stratification that are related to the diel temperature cycles. (Author's abstract)
W90-04629

ECOLOGY OF A WADI IN IRAQ WITH PARTICULAR REFERENCE TO COLONIZATION STRATEGIES OF AQUATIC MACROINVERTEBRATES.

Zoologische Staatssammlung Muenchen (Germany, F.R.).
M. Carl.

Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 4, p 499-515, 1989. 2 fig, 6 tab, 8 ref.

Descriptors: *Wadi, *Limnology, *Macroinvertebrates, *Aquatic habitats, *Colonization, Pools, Geomorphology, Seasonal variation, Species composition, Species distribution, Annelids, Aquatic insects, Mollusks, Gastropods, Iraq.

Aquatic invertebrates in a wadi are faced with unique environmental conditions because the valley is dry except for a short period during the rainy season. Colonization strategies of aquatic macroinvertebrates were studied in the remaining pool of a wadi, about 10 kilometers north of Baiji, Iraq, as well as in surrounding small stagnant waterbodies. Several species were able to survive in the only permanent water-filled pool, provided that the adults were mobile. Recolonization by flight originating from surrounding waters appeared to be the strategy most frequently used (92% of species). Analysis of the species distribution and numbers of individuals shows that the wadi pool and the surrounding waters had very different populations. Numerically, the Coleoptera and Heteroptera were dominant. (Author's abstract)
W90-04632

RICEFIELDS AS FILTERS.

Barcelona Univ. (Spain). Dept. de Ecologia.

E. Fores.

Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 4, p 517-527, 1989. 4 fig, 2 tab, 16 ref.

Descriptors: *Rice, *Biological filters, *Filter crops, *Dissolved solids, *Suspended solids, *Nutrients, *Nitrogen, *Phosphorus, Ebro Delta, Spain.

Filters can be defined as natural systems which are capable of retaining material in suspension or nutrients contained in the water which flows through them by physical or biological processes. The rice fields in the Ebro River Delta (NE Spain) retain particles with increasing efficiency as the crop develops. At the same time, the rice fields trap the oxidized inorganic nitrogen and phosphorus which enter the system. The most abundant nitrogen forms in the filtrate are dissolved organic nitrogen and ammonium. At the beginning of the crop season, dissolved organic phosphorus is retained, and toward the end of the season, soluble reactive phosphorus is retained. In general, the rice fields in the Ebro River Delta retain nitrogen and phosphorus in a proportion close to 14:1. The most efficiently retained element is phosphorus. (Author's abstract)
W90-04633

INTERACTIONS BETWEEN CHIRONOMUS PLUMOSUS (L.) AND THE MICROBIAL COMMUNITY IN SURFICIAL SEDIMENTS OF A SHALLOW, EUTROPHIC LAKE.

Uppsala Univ. (Sweden). Limnologiska Institutionen.

R. K. Johnson, B. Bostrom, and W. Van de Bund. Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 992-1003, September 1989. 4 fig, 4 tab, 38 ref. Swedish Natural Science Research Council Grant B-BV3083-112.

Descriptors: *Limnology, *Eutrophic lakes, *Lake sediments, *Midges, *Aquatic bacteria, Larvae, Feeding, Lake Vallentunasjön, Sweden.

Feeding by Chironomus plumosus larvae on sedimentary microbiota was studied in eutrophic Vallentunasjön, Sweden, where microbial biomass constitutes a large portion of sedimentary organic matter. The life history of C. plumosus consisted of two univoltine cohorts with an overall production of 1.4 g ash-free dry wt/sq m. Gut concentrations of bacteria, Microcystis, and Melosira were several times higher than sedimentary concentrations, indicating that the larvae are foraging selectively. Assimilation of bacteria and newly sedimented Melosira cells on average accounted for 11 and 49% of the estimated carbon requirements (production + respiration) of the larvae. Digestive efficiencies for bacteria and Melosira seasonally averaged 43 and 34%. Overwintering Microcystis colonies, which constitute the dominant proportion of microbial biomass in the sediments, were used to a small extent if at all as a carbon source by the chironomids. If a decrease in autofluorescence intensity of cells during gut passage is indicative of partial digestion of the cells, Microcystis was used with a digestive efficiency of 9% and accounted for 10% of the carbon requirements of the larvae. On the basis of ambient Chironomus densities, gut passage time, enrichment factor (gut vs. sedimentary density of bacteria), and digestive efficiency, chironomid grazing is not a dominant sink for sedimentary bacteria in Vallentunasjön. The feeding activity of Chironomus larvae decreased bacterial densities but increased the cell-specific production in laboratory experiments. The decrease was not proportional to grazer density, indicating that indirect effects of the chironomids (on sedimentary structure and chemistry) also affect the abundance of bacteria. (Author's abstract)
W90-04649

NITRIFICATION-DENITRIFICATION AT THE PLANT ROOT-SEDIMENT INTERFACE IN WETLANDS.

Florida Univ., Gainesville. Dept. of Soil Science. K. R. Reddy, W. H. Patrick, and C. W. Lindau. Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 1004-1013, September 1989. 2 fig, 6 tab, 37 ref. U.S. Agency for International Development DAN-1406-G-SS-4091-00.

Descriptors: *Limnology, *Wetlands, *Rooted aquatic plants, *Root zone, *Sediments, *Nitrification, *Denitrification, Rice, Pickerelweed, Soft rush, Oxygen gas, Nitrogen gas, Ammonium, Nitrates.

Oxygen transport through the air spaces (aerenchyma tissue) of the stem and roots of aquatic macrophytes into the root zone supports nitrification of ammonium, with the nitrate formed diffusing into the adjacent anaerobic zone where it undergoes denitrification. To test this hypothesis, a growth chamber study was conducted to determine the transformation of applied $^{15}\text{NH}_4(+) \text{N}$ to $^{15}\text{N}_2$ in the root zone of three aquatic macrophytes: rice (*Oryza sativa*), pickerel weed (*Pontederia cordata*) and soft rush (*Juncus effusus*). Detection of gaseous $\text{N}-^{15}\text{N}_2$ in the air above the floodwater of the soil column with aquatic plants provided direct evidence of nitrification-denitrification in the root zone, while such losses were not measurable for soil columns without plants. Air spaces in aquatic plants can also function as conduits for denitrified gases from anaerobic sediments to the atmosphere. Maximal $^{15}\text{N}_2$ flux due to this process was 102, 113, and 122 mg $\text{N}/\text{sq m}/\text{d}$ for soft rush, rice, and pickerel weed, respectively. This N loss mechanism has important agronomic and ecological consequences. (Author's abstract)
W90-04650

FORMATION AND BACTERIAL UTILIZATION OF DISSOLVED ORGANIC CARBON DERIVED FROM DETRITAL LIGNOCELLULOSE.

Georgia Univ., Athens. Inst. of Ecology. For primary bibliographic entry see Field 2L.
W90-04651

CHANGES IN PHYTOPLANKTON AND ZOOPLANKTON BIOMASS AND COMPOSITION REFLECTED BY SEDIMENTATION.

Eidgenössische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschulz, Dübendorf (Switzerland). Inst. of Aquatic Sciences. J. Bloesch, and H. R. Burgi. Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 1048-1061, September 1989. 4 fig, 7 tab, 64 ref.

Descriptors: *Switzerland, *Zooplankton, *Phytoplankton, *Seston, *Limnology, *Organic carbon, *Phosphorus, *Sedimentation, Chlorophyll a, Algae, Particulate organic matter, Crustaceans, Daphnia, Light quality, Limnocorral, Lake Lucerne.

Eight 2-week limnocorral (LC) experiments were performed in Lake Lucerne, Switzerland, during 1982-1984 to study the effects of biomaniipulation. The large zooplankton were removed by 95-micron plankton nets in some LCs and different phosphorus fertilization regimes were applied. The chlorophyll a and sestonic particulate organic carbon (POC) and particulate phosphorus (PP) concentrations decreased significantly in the presence of crustacean zooplankton, whereas algal biomass was less affected. Within the short period of 2 weeks this top-down regulation seemed to be balanced by bottom-up control, because phosphate fertilization and favorable light conditions stimulated phytoplankton production and increased seston concentrations. The significant shift from nanoplankton to net plankton in both the filtered and control LCs, which caused the sedimentation rates to increase during all the experiments, could not be attributed solely to selective zooplankton grazing but was also induced by different algal nutrient strategies. In the control (unfiltered) LCs, the herbivorous crustaceans (usually >80% *Daphnia* spp.) increased POC and PP sedimentation by 14-50 and 25-57% due to fecal pellet production. (Author's abstract)
W90-04652

EFFECT OF DAPHNIA BODY SIZE ON FILTERING RATE INHIBITION IN THE PRESENCE OF A FILAMENTOUS CYANOBACTERIUM.

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).

P. Hawkins, and W. Lampert.

Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 1084-1089, September 1989. 1 fig, 2 tab, 30 ref.

Descriptors: *Limnology, *Filter rate, *Daphnia, *Cyanophyta, *Competition, Feeding, Filamentous algae.

The hypothesis that shifts in the size structure of daphnid assemblages may be caused by differing sensitivities of particular species to interfering filamentous cyanobacteria was tested. Three *Daphnia* species of different size were fed the green alga *Scenedesmus* and filtering rates were measured in the presence and absence of straight filaments of the cyanobacterium *Cylindrospermopsis raciborskii*. *Cylindrospermopsis* was not lethally toxic to *Daphnia*, but was inadequate as the sole food. The filtering rates of all three *Daphnia* species were reduced in the presence of the filaments. The larger *D. pulex* and *D. hyalina* were more affected than the smallest *D. cucullata*, and within the size range of each species larger individuals were more affected than smaller ones. The results are consistent with field observations that body size is an important factor determining the competitive success of *Daphnia* species in the presence of cyanobacterial filaments. (Author's abstract)
W90-04653

INFLUENCE OF TRACE ELEMENTS ON AKINETE DIFFERENTIATION AND GERMINATION IN A BLUE-GREEN ALGA (CYANOBACTERIUM), NODULARIA SPUMIGENA.

Manipal Univ., Impal (India). Dept. of Life Sciences. D. D. Yumnam, and P. M. Reddy.

Field 2—WATER CYCLE

Group 2H—Lakes

Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 82, No. 3, p 371-379, 1989, 3 fig, 1 tab, 17 ref.

Descriptors: *Limnology, *Cyanophyta, *Germination, *Trace elements, *Trace metals, Molybdenum, Boron, Copper, Zinc, Bioaccumulation, Manganese, Nutrients, Algae.

Trace elements were found to influence akinete formation and germination in *Nodularia spumigena*. Omission of one trace element at a time from the medium resulted in varied degrees of reduction in akinete production and germination indicating differential influence of each trace element on these two developmental processes. Deletion of molybdenum (Mo) from the medium had no marked suppressive effect on akinete production. Akinete formation was suppressed more in boron (B), copper (Cu) or zinc (Zn) deficient medium than in the medium lacking manganese (Mn) or cobalt (Co). It appears that B, Cu and Zn have a more important role than Mn and Co in the processes leading to akinete development. Akinetes seem to be better equipped with sufficient endogenous reserves of B and Zn as a greater majority of akinetes were found to be less dependent upon exogenously supplied B and Zn for germination than upon Mn, Co, Cu and Mo. The pattern of germination relative to the position of heterocysts in the contiguous akinetes in sporulated filaments revealed a centripetal sequence in the absence of B, Cu or Zn and a centrifugal sequence in the absence of Mn, Co or Mo. These observations suggest heterocyst mediated preformation of increasing (B, Cu and Zn) or diminishing (Mn, Co and Mo) concentration gradients of trace elements towards heterocysts in the sporulated filaments. The evidenced differential accumulation of the trace elements in the cells of the sporulating filaments grown in the presence of the medium containing nitrate indicates that the heterocyst mediated gradient formation of the micronutrients is independent of the nitrogen-fixing activity of the heterocysts. (Author's abstract)

W90-04669

PERSISTENCE AND DISTRIBUTION OF PCBs IN THE SEDIMENTS OF A RESERVOIR (LAKE HARTWELL, SOUTH CAROLINA).
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W90-04682

STUDY OF HUMIC ORGANIC SUBSTANCES AND HEAVY METALS IN THE IVANKOVO RESERVOIR WATERS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 5B.
W90-04705

LAKE VATTEN, SWEDEN: A 20-YEAR PERSPECTIVE.
National Swedish Environment Protection Board, Uppsala (Sweden). Environmental Quality Lab.
G. Persson, H. Olsson, T. Wiederholm, and E. Willen.
AMBIO AMBOCX, Vol. 18, No. 4, p 208-215, 1989, 9 fig, 3 tab, 31 ref.

Descriptors: *Water pollution effects, *Air pollution effects, *Eutrophication, *Acid rain effects, *Oligotrophic lakes, *Sweden, Nitrates, Heavy metals, Organic pollutants.

Lake Vattern is one of the largest oligotrophic clear-water bodies in Europe. It is highly valued for recreation, fisheries, and as a drinking water reservoir. The lake is susceptible to pollutants derived both from the atmosphere and from tributaries and has been threatened by eutrophication and other pollution. Advanced sewage treatment reduced phosphorus inputs in the mid-1970s and the biotic communities are now recovering from eutrophication symptoms. The nitrate concentration in the lake has more than doubled in 20 years and is still constantly increasing, the reasons for which are discussed. Present day salt concentrations are 30% higher compared to concentrations before

World War II and deposition of acid pollutants have changed the ionic composition in favor of sulfate. The lake sediments are contaminated by zinc, cadmium, lead, and mercury, mainly from a mining operation at the lake and by chlorinated organic compounds from the bleach-plant effluents of a pulp mill. Laboratory tests indicated toxic effects of the sediments on a benthic organism. Levels of mercury, DDT and PCB in fish were approaching legislative criteria for human consumption in the late 1960s, but are now well below recommended levels. Relatively high concentrations of dioxins have recently been found in arctic char. (Author's abstract)

W90-04709

DIATOM-BASED PH RECONSTRUCTION OF LAKE ACIDIFICATION USING CANONICAL CORRESPONDENCE ANALYSIS.
Newcastle upon Tyne Univ. (England).
A. C. Stevenson, H. J. B. Birks, R. J. Flower, and R. W. Battarbee.
AMBIO AMBOCV, Vol. 18, No. 4, p 228-233, 1989, 3 fig, 26 ref.

Descriptors: *Paleolimnology, *Water pollution effects, *Hydrogen ion concentration, *Acid rain effects, *Diatoms, Statistical analysis, Canonical correspondence analysis, Cores, Scotland.

Current methods of quantitative pH reconstruction using diatoms from sediment cores involve the use of linear multiple regression. This approach has theoretical limitations since it assumes, inappropriately, that biological variables are monotonically related to environmental variables (e.g. pH). An alternative approach using canonical correspondence analysis and weighted averaging has greater validity, since it takes specific account of non-monotonic unimodal species responses. This method is initially applied to an existing data-set and subsequently a validation exercise is carried out on eight new surface samples. These show a close agreement between measured pH and canonical correspondence analysis reconstruction of pH using the existing surface data-set. Application of the technique to core data from southwestern Scotland shows good agreement with results using index B and multiple regression of pH groups. (Author's abstract)

W90-04711

NUTRIENT AND WATER FLUX IN A SMALL ARCTIC WATERSHED: AN OVERVIEW.
San Diego State Univ., CA. Dept. of Biology.
W. C. Oechel.
Holarctic Ecology HOECD2, Vol. 12, No. 3, p 229-237, Oct 1989, 4 fig, 1 tab, 39 ref. DOE Contract No. DE-FG03-84ER60250.

Descriptors: *Hydrologic budget, *Cycling nutrients, *Experimental basins, *Arctic zone, Tundra, Ecological effects, Primary productivity, Alaska.

The 'Response, Resistance, Resilience to, and Recovery from Disturbance in Arctic Ecosystems' program initially concentrated on impacts of altered water and nutrient inputs on tussock tundra vegetation. The intensive site is at Imnavait Creek (68 deg 37 min N, 149 deg 17 min E), near Toolik Lake, Alaska in the foothills of the Brooks Range, approximately 200 km south of Prudhoe Bay. Tussock tundra was selected for initial study because it has an extensive distribution in the Alaskan Arctic (80% of the arctic region), the majority of the pipeline corridor north of the Brooks Range passes through tussock tundra, and disturbances of arctic tundra are expected to occur in the future. Also important is that 18% of the circumpolar arctic primary productivity and 47% of the circumpolar arctic stored carbon are in tussock tundra. Water and nutrient additions were performed because they frequently accompany disturbance and development in the Arctic. Emphasis was placed on determining responses of physical, physiological, and ecosystem processes to environmental change in such a way that extrapolations to other areas would be facilitated. The hills near Imnavait Creek are covered by glacial till of the Sagavanirktok River glaciation, with a deep organic layer on the less exposed hill slopes and valleys. The vegetation

is dominated by *Eriophorum vaginatum*, *Betula nana*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Ledum palustre*, *Salix pulchra*, and *Sphagnum* spp. Winds were rarely calm but seldom exceed 17 m/s, generally from the east-southeast to the south-southwest (66%). Precipitation in 1986 was 344 mm, about half of which was snowfall. Mean temperature in 1986 was -8.1, with an absolute minimum of -43. Mean July temperature was between 9.8 and 13.7. Nutrients are more mobile than previously thought, moving an estimated 10 m downslope in the first growing season. It underscores the importance of the winter environment to biological and hydrological processes. Greater water flow results in increased plant growth rates, leaf area, and biomass. Effects of changes in nutrient and water supply on photosynthesis were minimal. Where increases in productivity took place, they occurred more likely as a result of changes in allocation patterns, including an initial redirection of carbohydrate stores to new leaf development, than from increases in photosynthetic rates. The work reported here indicates that the downslope transmission of nutrient and water flow effects caused by altered drainage and nutrient supply may result in a larger area of impact than previously thought. (Author's abstract)

W90-04712

HYDROLOGY OF IMNAVAIT CREEK, AN ARCTIC WATERSHED.
Alaska Univ., Fairbanks. Water Research Center.
For primary bibliographic entry see Field 2E.
W90-04713

SPATIAL INTERRELATIONSHIPS BETWEEN TERRAIN, SNOW DISTRIBUTION AND VEGETATION PATTERNS AT AN ARCTIC FOOTHILLS SITE IN ALASKA.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 2A.
W90-04714

STANDING BIOMASS AND PRODUCTION IN WATER DRAINAGES OF THE FOOTHILLS OF THE PHILIP SMITH MOUNTAINS, ALASKA.
San Diego State Univ., CA. Dept. of Biology.
S. J. Hastings, S. A. Luchessa, W. C. Oechel, and J. D. Tenhunen.
Holarctic Ecology HOECD2, Vol. 12, No. 3, p 304-311, Oct 1989, 2 fig, 4 tab, 33 ref. DOE Contract No. DE-FG03-84ER60250.

Descriptors: *Limnology, *Small watersheds, *Biomass, *Productivity, *Alaska, *Tundra, Vegetation, Species composition, Drainage effects.

In the foothills of the Philip Smith Mountains, Brooks Range, Alaska, tussock tundra is the most widely distributed vegetation, and it occurs on rolling hills and in valleys that were shaped by a sequence of Pleistocene glaciations. In this study, aboveground standing biomass and production were compared in 'intertrack tundra' areas that were relatively homogenous with respect to downslope drainage and adjacent 'water tracks' that acted to channel water flow to the valley bottom stream. Comparisons of biomass, leaf area index, and specific leaf weight were also made between upper and lower slope positions. Similarities and differences of vegetation structure are examined with respect to graminoid, deciduous shrub, evergreen shrub, herbaceous, and bryophyte components. Water tracks were found to have 1.5-1.7 times the biomass of intertrack tundra, and production (excluding secondary growth) in water tracks was 40% greater than in intertrack tundra. The aboveground biomass for all areas studied and the annual production values were similar to those found in other studies of tussock tundra. While only slight differences in depth of thaw occurred in water tracks and intertrack tundra during June and early July, water tracks thawed more deeply with the onset of summer rains. Warmer temperatures at 40 cm depth in July and August may have increased nutrient availability, whereas greater rooting depth and movement of water may have

increased nutrient capture in water tracks as compared with the intertrack areas. Greater biomass and a deeper thaw depth occurred at upper slope locations. (Author's abstract)
W90-04717

COMPARATIVE EFFECTS OF DOWNSLOPE WATER AND NUTRIENT MOVEMENT ON PLANT NUTRITION, PHOTOSYNTHESIS, AND GROWTH IN ALASKAN TUNDRA.
Florida International Univ., Miami. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2E.
W90-04719

CARBONATE SEDIMENTS IN LAKES OF YUNNAN, CHINA.
Y. Wang, W. Hu, and X. Zhang.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 2, p 122-130, 1989. 4 fig, 2 tab, 8 ref.

Descriptors: *Paleolimnology, *Lakes, *Sediments, *Carbonates, *China, *Geologic history, *Sedimentology, *Water chemistry.

The lakes in Yunnan have a complicated evolutionary history under the action of intensive neo-tectonism and regional physical conditions. As a result, carbonate sediments are accumulated slowly in the lakes. According to their appearance and origin, three kinds of carbonate sediments can be distinguished: (1) Organic shell carbonates which are mainly from gastropoda and lamellibranchia; (2) Micro-grained carbonate, including aragonite needles or radial aragonite aggregates, crypto-crystalline calcite lumps or monocrySTALLINE aggregates and dolomite; and (3) Clear-grained carbonate as lumps, pellets and ooids distributed in definite environmental area of the lakes. The lumps are composed of fine clastics cemented by crypto-crystalline carbonate and are considered the result of the biochemical sedimentation of microorganisms on the basis of total nitrogen analysis. The pellets are small ellipsoids consisting of micro-crystal calcite formed in an area with abundant algae. Calcite was converted into pellets due to activity of denitrifying bacteria in a micro-environment produced by algal metabolism. Ooids have laminae which show an alternation of calcite growing radially with aragonite growing in a tangential direction around the core. Their origin is likely related to temporary dryness of the lakes and hence a change in Mg/Ca ratio, causing alternated precipitation of calcite and aragonite. There are seldom large carbonate-forming organisms like those in marine waters. Therefore, carbonate sedimentation in lakes is mainly composed of micro-grained carbonate, but it is also possible for clear-grained carbonate to occur in some areas of the lakes, causing carbonate sedimentation. By studying the carbonate sedimentation in Chenghai Lake for the past 100 years, the general pattern of lacustrine carbonate sedimentation can be obtained. (Author's abstract)
W90-04721

SEDIMENTATION RATES OF PARTICULATE ORGANIC DETRITAL CARBON, NITROGEN AND PHOSPHORUS IN DONGHU LAKE, WUHAN.
For primary bibliographic entry see Field 2J.
W90-04723

BACTEREMIC CELLULITIS CAUSED BY NON-SEROGROUP O1 VIBRIO CHOLERAE ACQUIRED IN A FRESHWATER INLAND LAKE.
Abraham Lincoln School of Medicine, Chicago, IL. Section of Infectious Diseases.
For primary bibliographic entry see Field 5C.
W90-04724

ENVIRONMENTAL FACTORS AFFECTING PHYSIOGNOMIC AND FLORISTIC VARIATION IN AN AREA OF CERRADO IN CENTRAL BRAZIL.
Escola Superior de Agricultura de Lavras (Brazil). Dept. de Ciencias Florestais.

A. T. De Oliveira-Filho, G. J. Shepherd, F. R. Martins, and W. H. Stubblebine.
Journal of Tropical Ecology JTECEQ, Vol. 5, No. 4, p 413-431, Nov. 1989. 8 fig, 4 tab, 30 ref.

Descriptors: *Soil-water-plant relationships, *Ecological distribution, *Water table fluctuations, *Brazil, *Environmental gradient, *Savannas, *Topography, *Tropical regions.

Cerrado is a species-rich savanna-like vegetation that covers a large area in central Brazil. Soil, and particularly soil fertility, is considered to be the major factor determining the wide and diverse physiognomic-floristic gradients encountered within cerrado vegetation. To describe the vegetational variations within a cerrado in southern Mato Grosso state (15 deg 21 min S, 55 deg 49 min W), a 1 ha transect was located to pass through an interfluvial cerrado and climb a steep talus slope. The vegetational and environmental variations are described by means of field classification, direct gradient analysis and reciprocal averaging ordination. The effects of differences in ground water regime in the interfluvial cerrado and differences in inclination with associated rockiness in the talus cerrado are related to the vegetational variations. As the soils are very similar in texture and in the majority of chemical properties, the role of the above environmental factors was more easily distinguished. In the interfluvial cerrado, the vegetational variations are probably related to the seasonal fluctuation in water table level. (Author's abstract)
W90-04725

FACTORS INFLUENCING SALMONID POPULATIONS IN SIX HEADWATERS STREAMS, CENTRAL ARIZONA, USA.
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
J. N. Rinne, and A. L. Medina.
Polskie Archiwum Hydrobiologii PAHYA2, Vol. 35, No. 3/4, p 512-532, 1988. 9 fig, 1 tab, 27 ref.

Descriptors: *Stream biota, *Fish populations, *Trout, *Arizona, *Headwaters, *Aquatic habitats, *Population density, *Biomass.

Comparison of abiotic and biotic variables that could influence trout populations in six headwater streams, central Arizona (USA) suggests that physical habitat strongly influences salmonid density and standing crop. Stepwise regression analysis indicated that stream depth explained most of the variation in density and biomass of trout (66 and 77%, respectively). Stream substrate explained 11 and 9% of the variation in trout density and biomass, respectively. Livestock grazing is suggested as a significant contributor to increased substrate fines (less than 0.25 mm) and reduced fish populations in several of these streams. (Author's abstract)
W90-04729

SIGNIFICANCE OF TEMPERATURE AND FOOD AS FACTORS AFFECTING THE GROWTH OF BROWN TROUT, SALMO TRUTTA L., IN FOUR DANISH STREAMS.
Miljøstyrelsen, Silkeborg (Denmark). Freshwater Lab.
P. Geertz-Hansen, and E. Marcus.
Polskie Archiwum Hydrobiologii PAHYA2, Vol. 35, No. 3/4, p 533-544, 1988. 4 fig, 2 tab, 16 ref.

Descriptors: *Aquatic environment, *Growth, *Trout, *Denmark, *Temperature effects, *Fish food, *Limiting factors, *Seasonal variation.

The growth rates of brown trout, *Salmo trutta* L., were studied in four streams of contrasting character. The observed growth were compared with growth rates on the growth model for brown trout on maximum ration. In two streams the observed growth rates were also close to the predicted values during spring and summer, but during late summer and autumn great differences were seen. This indicates that food could not be excluded as a limiting factor in some Danish streams. (Author's abstract)
W90-04730

FISH PRODUCTION-BENTHOS PRODUCTION RELATIONSHIPS IN TROUT STREAMS.
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.

T. F. Waters.
Polskie Archiwum Hydrobiologii PAHYA2, Vol. 35, No. 3/4, p 545-561, 1988. 2 tab, 71 ref.

Descriptors: *Stream biota, *Fish populations, *Benthos, *Productivity, *Trout, *Fish food, *Aquatic environment, *Literature review.

The literature of fish production and benthos production in trout streams was reviewed with the objective of assessing the capability of benthos production to support estimated fish production. The results clearly indicated that almost all reported benthos production levels were much too low to be able to support levels of fish production commonly reported in trout streams. This conclusion was taken as a reaffirmation of the 'Allen paradox', which originated in the findings of Allen in the Horokiki Stream, New Zealand, who reported benthos abundance far too low to support the trout production in the stream. A number of other fish food resources-the hyporheos, snag habitat, floodplain fauna, terrestrial drift, meiofauna, other fishes-are suggested as additional sources of fish food which, when adequately measured, may solve the problem of the Allen paradox. (Author's abstract)
W90-04731

SURVEYING THE ENTIRE RIVER ECOSYSTEM.
Anglian Water Authority, Lincoln (England). Lincoln Div.
T. E. Coles, C. A. Extence, A. J. Bates, G. T. Oglanby, and C. Mason.
Polskie Archiwum Hydrobiologii PAHYA2, Vol. 35, No. 3/4, p 563-575, 1988. 3 fig, 4 tab, 28 ref.

Descriptors: *Limnology, *Rivers, *Ecosystems, *Surveys, *Biological samples, *Fish populations, *Invertebrates, *Riparian vegetation, *Birds.

The methodology and costs of surveys to assess river fish populations and aquatic invertebrates in Lincolnshire together with plant and bird communities along river corridors are described. Within Lincolnshire the majority of river sections are slow flowing with mud or silt substrates and the 'wrap around' technique is used to sample, while wading electrofishing is used to sample the remaining more quickly flowing sites with eroding substrates. The 'wrap around' technique over a series of 178 samples were found to capture 98% by numbers of the estimated population of fish (>5.5 cm) within the enclosed sections with the electrofishing samples averaging 87% by number (>5.5 cm) over 51 samples. Every stretch of maintained river within Lincolnshire has been divided, on large scale maps (1:25000) into sections approximately 500 m in length and given a code number. Maps covering the 800 sections currently being surveyed, are then used by the botanists and ornithologists undertaking the work. The main habitat features in the channel and on the banks of each section are mapped using the NCC methodology as well as marking on the maps the main plant communities, both in the water and on the banks. The breeding bird community is assessed from 4 visits to each section in April, May, June, and August, while the passage and winter birds are assessed from an additional 2 visits in October and December. These ecological surveys provide the basis of many aspects of river management. Fishery improvement work is based on fish biomass data available for every section of river while analysis of the population structure of the dominant fish species allows future fishery problems to be anticipated. Aquatic invertebrate surveys assess water quality and identify effluent requiring improvement while bird and plant surveys allow areas of wildlife interest to be protected. (Shidler-PTT)
W90-04732

DEVELOPMENT OF AN OPERATIONAL TWO-DIMENSIONAL WATER QUALITY

Field 2—WATER CYCLE

Group 2H—Lakes

MODEL FOR LAKE MARKEN, THE NETHERLANDS.

Rijksdienst voor de IJsselmeerpolders, Lelystad (Netherlands).

E. H. S. van Duin, and L. Lijklema.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1817-1820, 1989. 2 fig, 7 ref.

Descriptors: *Limnology, *Water pollution effects, *Lakes, *Data acquisition, *Water quality, *Model studies, Marken Lake, The Netherlands, Eutrophic lakes, WAQUA model, STRESS-2D model, Algal growth, Sampling, Seasonal variation, Shallow lakes.

A deterministic mathematical model is being developed for study of Lake Marken, a large, shallow, eutrophic lake in The Netherlands. It combines four submodels: WAQUA (for depth-averaged unsteady flow), STRESS-2D (for two-dimensional modeling of sediment transport, resuspension and sedimentation in shallow lakes), a one-dimensional light model to compute the available light in the water column from the irradiance and a suspended solids-related extinction coefficient, and a dynamic algal growth model. Sampling for model input is done as follows: high frequency (continuous) sampling at two stations, low frequency (every 16 days) sampling at 12 sites, and special sampling during 6 to 10 weeks a year to study the relationship between algal growth and the rate of vertical mixing in the water column. (Cassar-PTT)
W90-04779

EUTROPHICATION IN THE NETHERLANDS.

Agricultural Univ., Wageningen (Netherlands).
Dept. of Nature Conservation.

For primary bibliographic entry see Field 5C.
W90-04799

ORGANIC CARBON TRANSPORT IN AN UNDISTURBED BOREAL HUMIC RIVER IN NORTHERN FINLAND.

National Board of Waters, Oulu (Finland). District Office.
K. Heikkinen.

Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 1-19, November 1989. 5 fig, 6 tab, 49 ref.

Descriptors: *Dissolved organic carbon, *Nutrient transport, *Organic carbon, *Dissolved solids, *Particulate matter, *Rivers, *Stream discharge, *Floods, *Humic substances, Sediments, Decomposition, Seasonal variation, Algae, Kiiminkijoki River, Finland, Aquatic drift, Gulf of Bothnia.

The concentrations and transport rates of dissolved (DOC), particulate (POC) and total organic carbon (TOC) were investigated in the organically colored River Kiiminkijoki in the 1983 and 1984, and estimates were calculated for the amounts transported into the Gulf of Bothnia. DOC represents on the average 90% of the TOC transported and is probably mainly humic substances. The organic carbon concentrations increase with discharge with the major organic load restricted to the time of the spring floods. There is a hysteresis effect in organic transport at the beginning of a flood period. The positive dependence of DOC concentration on discharge indicates that the DOC is mainly of terrestrial origin, leaching mostly from the upper layer of living and dead Sphagnum and moderately humified peat in minerotrophic sapa mires. Autochthonous DOC sources also seem to be important in summer. The most important reasons for the decrease in DOC concentration under low flow conditions are probably sedimentation and decomposition of humic substances. The results indicate that the proportion of drifting algae as a POC source increases in summer. (Author's abstract)
W90-04804

DISSOLVED ORGANIC CARBON DYNAMICS OF DEVELOPED AND UNDEVELOPED WETLAND CATCHMENTS IN WESTLAND, NEW ZEALAND.

Canterbury Univ., Christchurch (New Zealand).
Dept. of Zoology.
K. J. Collier, R. J. Jackson, and M. J.

Winterbourn.

Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 21-38, November 1989. 5 fig, 3 tab, 35 ref.

Descriptors: *Carbon cycle, *Dissolved organic carbon, *Forest watersheds, *Wetlands, *Catchment areas, Stream discharge, Vegetation succession, Stemflow, Throughfall, Westland, New Zealand.

Annual dissolved organic carbon (DOC) budgets were calculated for three wetland catchments (10 ha) in Westland, New Zealand. One catchment was undeveloped whereas the other two were developed for pine forestry two and five years before the start of the study. DOC concentrations in stemflow and throughfall were highest at the undeveloped site, but soil water DOC concentrations were similar at all catchments. Concentrations of DOC in stream water increased as discharge increased up to about 1.0 l/s, after which a negative relationship was found. Export of DOC in stream water (28.7 to 37.8 g/sq m/y) increased with time after catchment development, suggesting evolution towards a steady state following succession of secondary vegetation within catchments. (Author's abstract)
W90-04805

SEASONAL CHANGES IN THE MACROFAUNA LIVING ON SUBMERGED PLANTS IN TWO LAKES OF DIFFERENT TROPHY.

Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.

R. Kornijow.

Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 49-60, November 1989. 6 fig, 26 ref.

Descriptors: *Submerged plants, *Mesotrophic lakes, *Eutrophic lakes, *Aquatic animals, *Trophic level, *Limnology, *Macroinvertebrates, Biomass, Population density, Lake Glebokie, Lake Piesczno, Poland, Seasonal variation.

Seasonal changes in the macrofauna living on submerged plants in the mesotrophic Piesczno and eutrophic Glebokie lakes (Poland) were studied over two annual cycles. The invertebrates associated with *Myriophyllum alternifolium*, *M. spicatum*, *Ceratophyllum demersum*, *Elodea canadensis*, *Potamogeton praelongus* and *P. lucens* were analyzed. Seasonal changes in the qualitative composition of the fauna were small. Strongly marked fluctuations, having the character of perceivable regularity, were recorded in dominance structure, density, and biomass in the case of the fauna inhabiting macrophytes and perennial above-ground shoots. Significant relationships were found between density and biomass of the fauna per unit plant mass to density and biomass per unit bottom area and to biomass of plants. (Author's abstract)
W90-04807

HETEROTROPHIC CAPABILITIES OF THE BLUE-GREEN ALGA OSCILLATORIA RUBESCENS.

Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Inst. de Limnologie. M. Feuillade, and J. Feuillade.

Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 61-76, November 1989. 3 fig, 3 tab, 46 ref.

Descriptors: *Cyanophyta, *Oscillatoria, *Metabolism, *Algal growth, *Limnology, *Heterotrophic algae, Organic compounds, Glucose, Sugar, Fructose, Acetates, Pyruvate, Amino acids, Light intensity, Radioactivity techniques.

The uptake of glucose, sucrose, fructose and acetate by the blue-green alga *Oscillatoria rubescens* was measured under darkness, high light and metalimnetic low light intensity by using C-14-labeled compounds added at natural concentrations. Uptake rates of added organics followed simple Michaelis-Menten kinetics. For glucose two linear components for the transport system were observed. Illumination had little effect on shapes of the curve. The respiratory loss of substrates ranged from 0.6 to 2.1% of the total amount of C assimilated for all substrates except acetate, for which the respiratory loss reached 13 to 21%. In terms of

the kinetics of assimilation, it appeared that *O. rubescens* might compete successfully with bacterial populations for glucose uptake in natural waters. However, neither the above organic substrates or three substrates (pyruvate, glutamate and an amino acid mixture) supported growth of axenic strain or natural population of *O. rubescens* in total darkness, at as much as 0.945 mM substrate concentration. Consequently, this blue-green alga was not considered as heterotroph. In dim light, a very slight growth was observed but only when experiments were started with a large inoculum; growth was not significantly increased when organic substrates were added. (Author's abstract)
W90-04808

PRE-IMPOUNDMENT STUDIES OF THE FISHES OF OWA STREAM SOUTH-WEST, NIGERIA.

Ogun State Univ., Ago-Iwoye (Nigeria). Dept. of Biological Sciences.

K. B. Olurin, and A. Sotubo.

Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 107-116, November 1989. 3 fig, 5 tab, 24 ref.

Descriptors: *Preimpoundment, *Streams, *Fish, *Nigeria, Species composition, Population density, Fish populations, Baseline studies.

A pre-impoundment investigation was conducted on the fish fauna of Owa stream, Nigeria during the period February to May 1987. Nine species belonging to 5 families were caught using mainly gillnets and baited hooks. Cichlidae was the most dominant family, represented by 4 species, followed by Notopteridae, represented by 2 species. The families Malapteruridae, Channidae and Anabantidae were represented by one species each. *Chromidotilapia guntheri* was the most dominant species both by number and weight, followed by *Tilapia mariae* and *Hemichromis fasciatus*. The length-weight relationship for the species showed allometric growth for *Xenomystus nigri*, *Papillocranus afer*, *C. guntheri*, *T. mariae* and *H. fasciatus*. The mean condition factor computed for the species showed that they were in good condition. There were no significant differences ($p > 0.05$) in condition with sex. (Author's abstract)
W90-04810

SOME PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON (SALMO SALAR) EXPOSED TO SOFT, ACIDIC WATER DURING SMOLTING.

Department of Fisheries and Oceans, Halifax (Nova Scotia). Biological Sciences Branch.

For primary bibliographic entry see Field 5C.

W90-04858

LAKE TAHOE: PRESERVING A FRAGILE ECOSYSTEM.

California Univ., Davis. Div. of Environmental Studies.

C. R. Goldman.

Environment ENVITAR, Vol. 31, No. 7, p 7-31, 1989. 4 fig, 20 ref.

Descriptors: *Lake Tahoe, *Land development, *Lakes, *Eutrophication, *Algal blooms, *Water pollution effects, *Lake management, *Regional planning, Regulatory agencies, California, Nutrients, Nevada.

An overview of the history of the development of Lake Tahoe and the surrounding area is presented. Over the last 30 years, water quality in Lake Tahoe has declined steadily despite the lake's large volume. As a result of increased nutrient availability in the lake's water, algal growth in the spring coats the rocks near shore, and the lake is losing its famous transparency. As a result of increasing concern about the condition of the lake, in 1970 California and Nevada created the Tahoe Regional Planning Agency (TRPA) to regulate further development in the basin. With increasing cooperation from the various state and federal agencies and clearer goals set by a 1980 agreement, TRPA began to enforce conservation practices based on a

basin-wide zoning plan that classified the land according to its suitability for development. In addition, regulations for maintaining water quality were adopted as the conservation forces gradually assumed a more aggressive and successful posture. Research and monitoring programs have been implemented that disseminate essential water quality information that offers support to regulatory, planning, and research activities in the Tahoe basin. Eutrophication studies have been conducted and ways to decrease inputs into the lake implemented. Tributary streams and atmospheric deposition have also been considered and studied. Essential to preserving a lake's ecological balance is the basic science necessary for understanding the structure, function, and coupling of terrestrial ecosystems. By developing an understanding of the workings of these fragile aquatic systems, it should be possible to conserve their quality. (White-Reimer-PTT) W90-04866

MICRO-ALGAE OF LAKE PUPUKE, AUCKLAND, NEW ZEALAND.

Department of Scientific and Industrial Research, Auckland (New Zealand). Botany Div. V. Cassie.

New Zealand Natural Sciences NZNSEZ, Vol. 16, p 39-50, 1989. 1 fig, 2 tab, 33 ref, append.

Descriptors: *Phytoplankton, *New Zealand, *Eutrophic lakes, *Algae, Diatoms, Desmids, Organic pollutants, Benthos, Toxicity, Cyanophyta, Chlorophyta, Seasonal variation, Aquatic populations, Species composition.

On the basis of its algal populations Lake Pupuke in New Zealand is classified as eutrophic. Over a period of 11 years, from 1976 to 1987, 96 taxa were identified in 102 algal samples obtained from mid-lake and inshore phytoplankton and phytobenthos, including metaphyton and epiphyton. Over the last 20 years at Lake Pupuke, winter dominance in the phytoplankton by desmids and dinoflagellates has remained fairly consistent. Compound indices of 2.0 for phytoplankton, 2.2 for periphyton, and 2.5 for all taxa, indicate that the lake is moderately eutrophic. Taxa tolerating a high degree of organic pollution were few in number, and were intimately associated either with swan excreta or with overflow discharges from drains and pumping stations. It appears that algal populations in both phytoplankton and phytobenthos have remained fairly stable or become smaller since the removal of large quantities of floating macrophytes, and hence of large quantities of nutrients. Another factor limiting micro-algal growth, as yet not clearly defined, could be the presence of a toxic chemical or chemicals, e.g. excess hydrogen sulfide, or some substance entering the lake ecosystem from the hospital or other drains. (White-Reimer-PTT) W90-04873

EFFECT OF A CAVE ON BENTHIC INVERTEBRATE COMMUNITIES IN A SOUTH ISLAND STREAM.

Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology. R. G. Death.

New Zealand Natural Sciences NZNSEZ, Vol. 16, p 67-78, 1989. 3 fig, 4 tab, 21 ref.

Descriptors: *Invertebrates, *New Zealand, *Stream biota, *Caves, Periphyton, Biomass, Colonization, Drift, Density, Species diversity, Food resources.

Cave Stream is a second order tributary of Broken River that rises in the foot hills of the Craigburn Range, Canterbury. A study was conducted to investigate whether: (1) periphyton biomass was reduced in the cave, and if so, whether this precluded colonization by invertebrates; (2) the cave prevented colonization of downstream reaches of the stream by drift; and (3) this in turn affected community composition in the downstream reaches. Stone surface organic layers were absent inside the cave but well developed outside. Invertebrate densities were considerably lower inside than outside the cave although relative abundances of taxa were not markedly different. Drift rates and densities were higher at the inlet end of the

cave than at the outlet indicating that the cave acted as a drift barrier to some invertebrate species, which may have been unable to survive on the low food resources inside. Despite a reduction in numbers of animals drifting into the downstream reaches of Cave Stream, community structure was not significantly different from that upstream of the cave. This suggests the importance of oviposition and upstream migration as primary means of colonization for many taxa. (White-Reimer-PTT) W90-04874

GREAT LAKES WATER QUALITY AGREEMENT.

Limno-Tech, Inc., Ann Arbor, MI.

P. L. Freedman, and B. A. Monson.

Water Environment and Technology, Vol. 1, No. 2, p 284-291, October 1989. 3 fig, 1 tab.

Descriptors: *Lakes, *Water pollution control, *Water quality, *International agreements, *Great Lakes, Water resources management, Legislation, Comprehensive planning.

Conflicts concerning Great Lakes use have impacted its quality and, to some extent, its beneficial uses. These problems have been, and still are, diverse ranging from bacteria to eutrophication to toxic materials. Such problems prompted governmental action and controls at the local, state, provincial, national and international levels. Through the combined efforts of the public, government and industry, substantial gains have been made in maintaining and restoring conditions in the Great Lakes, but more efforts are needed. Binational agreements between Canada and the U.S. are targeted at this need. The Great Lakes Water Quality Agreement of 1972 (GLWQA), an international master plan for Great Lakes protection without enforcement language, has been amended as recently as 1987. The GLWQA currently impacts only eight states and one province, but its implications will likely trigger environmental actions nationwide. The goals of the GLWQA include: (1) eliminating or reducing pollutant discharges; (2) developing lists of point-source impacts, areas of concern, and critical pollutants; (3) developing management plans; and (4) developing plans for development and support for programs. (Male-PTT) W90-04875

SEASONAL DYNAMICS OF PRODUCTION, AND NUTRIENT ACCUMULATION AND CYCLING BY PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STUEDEL IN A NUTRIENT-ENRICHED SWAMP IN INLAND AUSTRALIA. I. WHOLE PLANTS.

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research. P. J. Hocking.

Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 4, p 421-444, 1989. 8 fig, 8 tab, 54 ref.

Descriptors: *Marshes, *Marsh plants, *Cycling, *Wetlands, *Limnology, *Australia, *Swamps, Nutrients, Seasonal variation, Plant growth, Biomass, Plant physiology, Phragmites.

Seasonal changes in dry matter production and patterns of nutrient accumulation by *Phragmites australis* in a nutrient-enriched swamp in inland Australia were studied. The density of live shoots was highest (224/sq m) in October, but the peak standing crop of live shoots (9890 g/sq m) occurred in early May. Peak below-ground biomass (21,058 g/sq m) occurred in early August. Rhizome biomass constituted 75% of the below-ground biomass, and showed a distinct seasonal pattern. Net annual above-ground primary production (NAAP), estimated by the maximum-minimum method, was 9513 g/sq m to the negative 2. Correction for shoot mortality and leaf shedding before, and production after, the maximum standing crop was attained increased NAAP to 12,898 g/sq m. Whole plant production estimated by the maximum-minimum method was 9960 g/sq m, and the corrected estimate was 14,945 g/sq m. A model of dry-matter production indicated that transloca-

tion of carbohydrate from rhizomes could have provided 33% of the dry matter of shoots. About 23% of the dry matter of shoots was redistributed to below-ground organs during senescence. Concentrations of nitrogen, phosphorous, potassium, sulfur, chlorine and copper declined, but concentrations of calcium, magnesium, sodium, iron and manganese increased as shoots aged. Concentrations of nitrogen, phosphorous and zinc in rhizomes reached maxima in winter, and decreased in spring. Rhizomes usually contained the greatest quantity of a nutrient in the whole plant, and roots usually had less than 25% of the total plant content. There were seasonal fluctuations in the quantities of nitrogen, phosphorous, potassium, zinc and copper in rhizomes. Nutrient accumulation by live shoots was underestimated by 22-55% using the maximum-minimum method. Nutrient budgets showed considerable internal cycling of nitrogen, phosphorous, potassium, sulfur and copper from rhizomes to developing shoots in spring, and from senescing shoots to rhizomes during autumn and winter. (See also W90-04883) (Author's abstract) W90-04882

SEASONAL DYNAMICS OF PRODUCTION, AND NUTRIENT ACCUMULATION AND CYCLING BY PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STUEDEL IN A NUTRIENT-ENRICHED SWAMP IN INLAND AUSTRALIA. II. INDIVIDUAL SHOOTS.

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research. P. J. Hocking.

Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 4, p 445-464, 1989. 9 fig, 7 tab, 49 ref.

Descriptors: *Marshes, *Australia, *Cycling nutrients, *Marsh plants, *Wetlands, *Limnology, *Swamps, Plant populations, Phragmites, Bioaccumulation, Plant physiology, Plant tissues.

The seasonal dynamics of the growth of shoots of *Phragmites australis*, and the partitioning of dry matter and 12 mineral nutrients between shoot organs, were studied in a stand in a nutrient-enriched swamp in inland Australia. The stem accumulated over 75% of the total-shoot dry matter, the inflorescence less than 5%. About 26% of the shoot dry matter was redistributed to below-ground organs during senescence. Potassium and nitrogen were the most concentrated macronutrients in shoots, followed by chlorine, calcium, sulfur, phosphorous, magnesium and sodium, decreasing respectively. Micronutrient concentrations were in the order manganese, iron, zinc and copper, decreasing respectively. Concentrations of most nutrients and total amino compounds were higher in leaves than stems. Concentrations of nitrogen, phosphorous and potassium were highest in young shoots and decreased throughout the season, whereas concentrations of calcium, chlorine, iron, manganese and sodium increased during the life of the shoot. The top of the shoot had the highest concentrations of nutrients. Calcium and manganese accumulated mainly in the large leaves from the middle of the shoot. The stem contained the major proportion of the quantity of most nutrients in living shoots; however, leaves had over 55% of the total shoot content of nitrogen, calcium and manganese. The inflorescence usually had less than 10% of the quantity of a nutrient in the shoot, but had over 20% of the nitrogen and 32% of the phosphorous in the shoot. Nitrogen, phosphorous and potassium were redistributed from senescing shoots to below-ground organs with over 60% efficiency, and sulfur, magnesium, zinc and copper with between 17 and 38% efficiency. There was negligible redistribution of calcium, chlorine, sodium, iron or manganese from either leaves or stems. Nutrients were redistributed to a greater extent from leaves than from stems. There were leaching losses of some nutrients from exposed senescing shoots, especially with potassium, chlorine and sodium. Leaching losses of sodium were low (circa 5%). Shoots from part of the reed-bed burnt the previous winter were smaller, had fewer leaves, and had lower concentrations of most nutri-

Field 2—WATER CYCLE

Group 2H—Lakes

ents than those from the unburnt part of the reed-bed. (See also W90-04882) (Author's abstract) W90-04883

BREAKDOWN OF FOUR LEAF LITTER SPECIES AND ASSOCIATED FAUNA IN A BASQUE COUNTRY FORESTED STREAM. Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecología.

J. B. Imbert, and J. Pozo.

Hydrobiologia HYDRB8, Vol. 182, No. 1, p 1-14, 1989. 7 fig, 3 tab, 31 ref.

Descriptors: *Litter, *Macroinvertebrates, *Detritus, *Midges, *Species diversity, Spain, Decomposition, Stream ecology, Invertebrates, Pine trees, Oak trees.

Leaves of 4 tree species (*Quercus robur*, *Castanea sativa*, *Corylus avellana* and *Pinus pinaster*) were incubated in a forested headwater stream using bags (1 millimeter and 5 millimeter net size) and trays (5 millimeter net size). The type of treatment influenced litter breakdown rates. Differences in loss rates were noted between *Pinus* and the deciduous species, and between *Quercus* and *Corylus*. Numbers of invertebrates per sample and per gram leaf ash free dry weight generally increased with exposure time. The taxa colonizing the four leaf species were largely identical but colonization was greatly dependent on type of treatment. Taxa richness (H_{max}) increased with time. Differences between H_{max} and specific diversity (H') were high, due to the importance of Chironomids. Collectors and scrapers, among other functional groups, exhibited the highest densities. Differences in loss rates between fine and coarse treatments were related to differences in shredder biomass, corroborating the importance of this functional group in litter processing. (Author's abstract) W90-04884

SUMMER BACTERIAL POPULATIONS IN MISSISSIPPI RIVER POOL 19: IMPLICATIONS FOR SECONDARY PRODUCTION.

Illinois Natural History Survey, Champaign. Aquatic Biology Station.

M. S. Henebry, and R. W. Gorden.

Hydrobiologia HYDRB8, Vol. 182, No. 1, p 15-23, 1989. 3 fig, 3 tab, 34 ref. Supported by the NSF, Division of Biotic Systems and Resources, under the Long-Term Ecological Research Program Grants No. 81-14563 and 86-12107.

Descriptors: *Aquatic bacteria, *Rivers, *Bacterial analysis, *Mississippi River, *Biomass, Aquatic plants, Carbon, Aquatic productivity.

Bacterial populations were sampled at 37 sites in Mississippi River Pool 19. Bacterial biomass was calculated from direct epifluorescent cell counts. Bacterial production was estimated by incubating cells in situ in predator-free water inside membrane chambers and the frequency of dividing cells. Bacterial biomass in the water column ranged from 0.05 to 1.13 mg C/L, biomass in the vegetated areas of the pool was significantly higher than that in other habitats (P less than 0.05, ANOVA). Biomass in sediments (to a depth of 10 centimeters) ranged from 24 to 1,073 mg C/sq m; biomass in muddy sediments was significantly higher (P less than 0.05) than that in sandy sediments. Biomass on the submersed surfaces of hydrophytes was 0.06 to 4.90 mg bacterial carbon/g dry weight of plant material. The vegetated habitat (water column plus vegetation) contained approximately 45 times the concentration of bacterial carbon found in nonvegetated main channel border areas and more than 100 times the concentration in the main river channel. Bacterial production rates in the water column of a vegetated section of the pool ranged from 0.03 to 3.28 g of carbon/cu m/d; production (cu m) in a vegetated bed was 5.5 times that in the adjacent nonvegetated channel border areas and approximately 50 times that in the main channel. Aquatic macrophytes and associated microorganisms may be capable of providing significant inputs of carbon to secondary consumers in the pool during the summer low flow. (Author's abstract) W90-04885

EXAMINATION OF A FRESHWATER SURFACE MICROLAYER FOR DIEL CHANGES IN THE BACTERIONEUSTON.

Wisconsin Univ., Milwaukee. Center for Great Lakes Studies.

J. S. Maki, and C. C. Remsen.

Hydrobiologia HYDRB8, Vol. 182, No. 1, p 25-34, 1989. 2 fig, 3 tab, 50 ref. Work supported in part by the Center for Great Lakes Studies, University of Wisconsin-Milwaukee.

Descriptors: *Plankton, *Aquatic bacteria, *Limnology, *Bacteria, Bacterial analysis, Microorganisms, Diurnal variation, Organic carbon, Phosphorus, Ammonia, Correlation analysis.

The surface microlayer of a small freshwater pond was sampled every 6-8 hours on four occasions (April, July, September and November) to examine changes in total and respiring bacterioneuston for diel cycles and comparing them to similar measurements of the bacterioplankton. Dissolved organic carbon (DOC), dissolved reactive phosphorus (DRP) and ammonia nitrogen (NH_3-N) were also measured. Both the mean numbers and enrichments of the two bacterial parameters in the surface microlayer samples showed seasonal differences, but in general, no significant difference (P greater than 0.05, ANOVA) in the mean numbers of total and respiring bacterioneuston were observed over diel periods except in November. The converse was true for the bacterioplankton. The presence of a visually thick surface film contributed to the results. The mean numbers of bacterioneuston and their enrichments were not correlated to any of the physical/chemical parameters measured. (Author's abstract) W90-04886

COMMUNITY STRUCTURE IN EPIPLIMNETIC AND METALIMNETIC PHYTOPLANKTON ASSEMBLAGES.

Windsor Univ. (Ontario). Great Lakes Inst.

G. D. Haffner, and R. McNeely.

Hydrobiologia HYDRB8, Vol. 182, No. 1, p 59-71, 1989. 7 fig, 15 ref.

Descriptors: *Lakes, *Phytoplankton, *Limnology, Community structure, Correlation analysis, Epilimnion, Metalimnion, Temporal distribution, Vertical distribution, Canada.

Epilimnetic and metalimnetic phytoplankton communities were compared to assess the relative importance of autogenic and allogenic factors regulating community composition and structure. In the epilimnion, opportunistic species were predominant, and as a result there was considerable temporal change in the community as measured by the community coefficient. In the metalimnion, however, temporal changes in the community coefficient were small compared with changes along the vertical gradient. It appears that non-equilibrium dynamics caused by short term changes in physical processes might be regulating the phytoplankton community in the epilimnion, and vertical niche partitioning along the vertical gradient was minor compared with temporal changes of community structure. The metalimnion supported communities with a more persistent structure over time, although vertical resource partitioning between density layers resulted in considerable change of community structure with depths. (Author's abstract) W90-04887

SEASONAL DYNAMICS OF BENTHIC MACROINVERTEBRATE COMMUNITIES IN THE LOWER ARDECHE RIVER (FRANCE).

Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.

S. Doledec.

Hydrobiologia HYDRB8, Vol. 182, No. 1, p 73-89, 1989. 7 fig, 3 tab, 38 ref. Hydrobiological study of the Lower Ardecche River was supported by a grant from the Reserve Naturelle des Gorges de L'Ardecche.

Descriptors: *Benthic fauna, *France, *Ecosystems, *Rivers, Seasonal variation, Community structure, Temperature, Light, Mediterranean.

Seasonal sampling at six locations on the Lower Ardecche River, France, indicated that the community structure varied irregularly during the 1982, 1983 and 1984 sampling program. The seasonal structure of the taxa-sample matrix, which was much more important than sample location, is demonstrated graphically. The Mediterranean aspect of the lower reaches of the Ardecche River is indicated by the community structure which includes species often collected in other typical Mediterranean streams, (e.g. *Oligoneuriella rhenana*, *Ephoron virgo*, *Ecdyonurus dispar*, *E. insignis*, *Choroterpes picteti*). Results also indicated that water temperature and day length were the determining influences on seasonal variations in the population structure of benthic macroinvertebrates. Three seasonal periods were distinguished: winter (November to April), spring (May, June and beginning July) and summer (end of July to October). Spring and autumnal spates marked the limits of the summer and winter periods. Hence, annual fluctuations of this seasonal typology may occur in response to the hydrological regime. (Author's abstract) W90-04888

GENERATION OF TIME OF ACANTHOCYCLOPS ROBUSTUS IN RELATION TO FOOD AVAILABILITY AND TEMPERATURE IN A SHALLOW EUTROPHIC LAKE.

University of East Anglia, Norwich (England). School of Biological Sciences.

M. Cryer, and C. R. Townsend.

Hydrobiologia HYDRB8, Vol. 182, No. 2, p 93-97, 1989. 1 fig, 3 tab, 22 ref.

Descriptors: *Copepods, *Zooplankton, *Eutrophic lakes, *Limnology, Productivity, Temperature, Food chains, Regression analysis.

The generation time of the predatory cyclopoid copepod *Acanthocyclops robustus* was estimated on 11 occasions during the years 1980 to 1982 in Alderfen Broad New Zealand. In a multiple regression model, generation time was found to be uncorrelated with temperature, positively correlated (P less than 0.001) with the density of nauplii of the calanoid copepod *Eudiatomus gracilis*. It is suggested that generation time was determined largely by the availability of calanoid nauplii as prey, even though these constituted only 2% of zooplankton standing biomass. (Author's abstract) W90-04889

SEASONALITY IN RIVER PHYTOPLANKTON: MULTIVARIATE ANALYSES OF DATA FROM THE OHIO RIVER AND SIX KENTUCKY TRIBUTARIES.

Louisville Univ., KY. Dept. of Biology.

C. G. Peterson, and R. J. Stevenson.

Hydrobiologia HYDRB8, Vol. 182, No. 2, p 99-114, 1989. 6 fig, 3 tab, 42 ref.

Descriptors: *Water chemistry, *Water quality, *Ohio, *Kentucky, *Seasonal variation, *Phytoplankton, *Monitoring, Rivers, Physicochemical properties, Dominance, Cyanophyta, Diatoms.

Two years of physical/chemical and algal abundance data obtained from national Stream-Quality Accounting Network records of 10 river sites in Kentucky (4 Ohio River sites and 6 Ohio River tributaries) were analyzed to determine how seasonal changes in river phytoplankton related to changes in physical and chemical parameters. Phytoplankton assemblages differed among rivers as a function of drainage basin characteristics, but exhibited common seasonal changes related to temporal variation in the physical/chemical environment. Distinct shifts in algal dominance were identified between spring (March, April), late summer (July, August, September), and transitional (May, June, November) periods in the 10 systems. Nine common algal genera were found to differ in their response to changes in physical or chemical parameters. Abundances of *Anacystis*, *Oscillatoria*, *Scenedesmus*, and *Melosira* were strongly related to temperature. Other physical/chemical factors that were significantly positively (+) or negatively (-) correlated with algal abundances included dis-

charge and alkalinity (*Oscillatoria*, +), pH carbon (*Chlamydomonas* and *Cyclotella*, both +), turbidity (*Navicula*, +), silica (*Cyclotella*, -), and ammonium/organic nitrogen (*Anacystis*, -). Genera within the same algal division exhibited different seasonal patterns and responded to different physical/chemical parameters. (Author's abstract)
W90-04890

PHYTOPLANKTON EXTRACELLULAR DISSOLVED ORGANIC CARBON PRODUCTION IN A HYPERTROPHIC AFRICAN LAKE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. R. D. Robarts, and L. M. Sephton.
Hydrobiologia HYDRB8, Vol. 182, No. 2, p 137-148, 1989. 4 fig, 2 tab, 39 ref.

Descriptors: *Productivity, *South Africa, *Limnology, *Phytoplankton, *Organic carbon, Lakes, Spatial distribution, Temporal distribution, Light.

The spatial and temporal changes in phytoplankton (predominantly *Microcystis aeruginosa*) production of particulate organic carbon (primary production) and extracellular dissolved organic carbon (EDOC) were measured in hypertrophic Hartbeespoort Dam, South Africa, for 5 years. The study objectives were to determine the significance of EDOC production to primary production estimates and to identify the dominant factors associated with EDOC production. Primary production at the lake surface varied between 9.4 and 8886 mg C/cum/h while EDOC production ranged from 0.9 to 1410 mg C/cum/h. Surface EDOC production represented a mean of 8.1% (range 1.0-63.0%) of total organic carbon production. Integrated euphotic zone primary production had a mean value of 665 mg C/sq m/h (range 46.3-3010 mg C/sq m/h) while EDOC production varied between 2.1 and 540 mg C/sq m/h (mean = 27.6 mg C/sq m/h). As a percentage of total production, EDOC represented a mean of 4.5% (range 0.6 to 32.4%). The dominant factor correlated to EDOC production at all depths, and for the euphotic zone, was the rate of primary production ($r = \text{approximately } 0.7$, $n = 222$, p -value less than 0.001). In the upper euphotic zone solar radiation was not significantly correlated to EDOC production ($r = 0.1$, $n = 221$, and p -value greater than 0.05). It was concluded that although the production of EDOC during the routine measurement of primary production in Hartbeespoort Dam was not significant, the production of labile dissolved organic carbon compounds by phytoplankton was probably important when viewed in the context of the biological cycling of dissolved organic carbon. (Author's abstract)
W90-04892

VEGETATION OF THE SPECIAL ZOOLOGICAL RESERVE OF KOPACKI RIT.
Osijek Univ. (Yugoslavia).
For primary bibliographic entry see Field 2I.
W90-04893

ABUNDANCE AND FEEDING OF MICROHETEROTROPHIC FLAGELLATES FROM A EUTROPHIC LAKE.
Murray State Univ., KY. Dept. of Biological Sciences. J. R. Pratt, and J. D. Chappell.
Hydrobiologia HYDRB8, Vol. 182, No. 2, p 165-169, 1989. 1 fig, 1 tab, 16 ref.

Descriptors: *Plankton, *Aquatic bacteria, *Eutrophic lakes, *Limnology, Microorganisms, Flagellates, Bacterial analysis, Predation, Zooplankton, Flagellates, Growth.

The growth of planktonic bacteria from a eutrophic lake was evaluated with microflagellate predators present and absent. Differential filtration (50 and 8 micrometer filters) was used to exclude ciliates and larger zooplankton and phytoplankton from replicate experimental cultures. Additional filtration (1 micrometer filter) excluded heterotrophic microflagellates from a second set of experimental cultures, producing cultures that contained

either bacteria and microflagellates or only bacteria. Growth of bacteria and microflagellates was evaluated by epifluorescent microscopy from repeated sampling over approximately 200 hours. Bacterial numbers were reduced in the presence of microflagellates, and microflagellates were observed to contain bacterial prey. However, microflagellate numbers were high (about one million cells per milliliter) and were less than an order of magnitude lower than bacterial numbers. Bacteria growing in the presence of microflagellates did not show predator-prey population oscillations but had in-phase oscillations in number, suggesting rates of heterotrophic microflagellates, estimated to be only 30 body volumes per hour, were insufficient to maintain flagellate growth, suggesting that other energy sources may be needed to maintain microflagellates in eutrophic freshwater ecosystems. (Author's abstract)
W90-04895

EFFECT OF LEAF PACK COMPOSITION ON PROCESSING: A COMPARISON OF MIXED AND SINGLE SPECIES PACKS.
Savannah River Ecology Lab., Aiken, SC. L. G. Leff, and J. V. McArthur.
Hydrobiologia HYDRB8, Vol. 182, No. 3, p 219-224, 1989. 4 fig, 1 tab, 14 ref. DOE contract DE-AC09-76SR00.

Descriptors: *Decomposition, *Detritus, Decomposing organic matter, Macroinvertebrates, Leaves, South Carolina.

The effect of leaf species composition on decomposition patterns was examined in a coastal plain stream. Red maple leaves (*Acer rubrum*) decomposed at the same rate separately or when mixed with cypress leaves (*Taxodium distichum*). Cypress addition increased structural integrity but its effects differed between sites with different hydrologic regimes. Invertebrate communities varied slightly between mixed and single species packs, however invertebrates did not appear to be the primary agent of decomposition. Mixed species packs may be an alternative method to fine mesh bags for studying processing of small, narrow leaves in a more realistic manner. (Author's abstract)
W90-04896

WINTER ABUNDANCE OF CHANNEL CATFISH IN THE CHANNELIZED MISSOURI RIVER, NEBRASKA.
Nebraska Game and Parks Commission, Lincoln. B. A. Newcomb.
North American Journal of Fisheries Management NAJMF, Vol. 9, No. 2, p 195-202, Spring 1989. 3 fig, 5 tab, 20 ref. National Marine Fisheries Service Project 2-402-R, under Public Law 88-309.

Descriptors: *Fish populations, *Catfish, *Channeling, *Ecological effects, *Missouri River, *Nebraska, Aquatic habitats, Population dynamics, Seasonal variation, Dikes.

The objective of this study was to estimate and compare the population abundances and size structures of channel catfish *Ictalurus punctatus* wintering in rock dike habitats in several channelized sections of the Missouri River. Electrofishing was used to sample channel catfish populations at four locations along the Missouri River in the winter months of 1983-1987. Deep scour holes in eddy current areas associated with rock wing dike structures provided valuable winter habitats for many fish species. Channel catfish were only collected from dike habitats with depths greater than 12 feet and water velocities less than 0.90 feet per second. A significant positive relationship was revealed between the number of channel catfish collected per river mile and the species' estimated density based on mark-recapture experiments. Tag returns documented a seasonal pattern of movement from the wintering habitat of the Missouri River to tributary streams during warmer months. (Author's abstract)
W90-04916

DISTRIBUTION OF FLORIDA LARGEMOUTH BASS IN A LAKE AFTER ELIMINATION OF ALL SUBMERGED AQUATIC VEGETATION.
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture. D. E. Colle, R. L. Cailteux, and J. V. Shireman.
North American Journal of Fisheries Management NAJMF, Vol. 9, No. 2, p 213-218, Spring 1989. 3 tab, 22 ref.

Descriptors: *Limnology, *Lakes, *Sunfish, *Submerged plants, *Distribution patterns, Aquatic habitats, Deep-water habitats, Piers, Adaptation, Florida.

Distribution of 16 Florida largemouth bass *Micropterus salmoides floridanus* was monitored weekly for one year by radiotelemetry in 80-hectare Lake Baldwin, Florida. The lake contained grass carp *Ctenopharyngodon idella*, which had eliminated all submerged aquatic macrophytes. Six of the largemouth bass stayed predominantly (87 percent of tracking locations) in water deeper than 3.5 meters (60 percent of lake surface area), where they established home ranges averaging 21.0 hectares (range, 0.6-39.5 hectares); the offshore region had no natural or artificial structures. The other radio-tagged fish were relocated a majority of times in water depths of 3.5 meters or less. Five of these fish established year-round home ranges averaging 4.1 hectares (range, 1.0-9.8 hectares) in the inshore region where water depths were less than 2.0 meters, and had significant (P -value less than 0.05) preferences for habitats with water tupelo *Nyssa aquatica*. The remainder of the largemouth bass used both the inshore region and water depths out to 3.5 meters and had significant preferences for the 11 piers in Lake Baldwin. (Author's abstract)
W90-04917

INFLUENCES OF INTERSTICE SIZE, SHADE, AND PREDATORS ON THE USE OF ARTIFICIAL STRUCTURES BY BLUEGILLS.
Ohio State Univ., Columbus. School of Natural Resources. W. E. Lynch, and D. L. Johnson.
North American Journal of Fisheries Management NAJMF, Vol. 9, No. 2, p 219-225, Spring 1989. 2 tab, 2 fig, 27 ref.

Descriptors: *Lakes, *Aquatic habitats, *Bluegills, *Ecological distribution, *Artificial substrates, Sunfish, Juvenile growth stage, Mature growth stage.

Adding artificial structures to lakes concentrates fish and therefore may increase angler success. However, structure characteristics that attract fish are not well understood. The purpose of this study was to evaluate the preferences of juvenile and adult bluegills *Lepomis macrochirus* for interstice size (40, 150, and 350 millimeters) within artificial structures and shaded versus unshaded structures in the absence or presence of largemouth bass *Micropterus salmoides*. Structures were constructed of 10-centimeter-diameter plastic pipes and were 1.2 meters by 1.2 meters by 1.5 meters in size. Juvenile (50-100 millimeters total length, TL) and adult (greater than 150 millimeters TL) bluegills consistently preferred 40-millimeter interstices with a structure on any given day, which suggested that small structures such as ours may have a limited carrying capacity for bluegills. Use of structures by largemouth bass appeared to be related to their body size. Small individuals (less than 300 millimeters TL) used structures with 40-millimeter or 350-millimeter interstices, whereas larger fish used only 350-millimeter interstices. (Author's abstract)
W90-04918

WATERWEED INVASIONS.
Toronto Univ. (Ontario). Dept. of Botany.
For primary bibliographic entry see Field 4A.
W90-04920

RESTORING THE GREAT LAKES.
V. Adamkus.
EPA Journal, Vol. 11, No. 2, p 2-4, March 1985.

Field 2—WATER CYCLE

Group 2H—Lakes

Descriptors: *Lakes, *Water pollution, *Great Lakes, *Lake fisheries, *Lake restoration, *Phosphorus, *Water pollution control, *Eutrophic lakes, Environmental Protection Agency, Ships, Water pollution effects, Potential water supply, Fish, Chemical wastes.

The decline of the Great Lakes that was recognized in the 1960s has been halted. By the summer of 1984, all but 8 of the lakes' 516 beaches had reopened and water quality has significantly improved. While the problem of eutrophication has been drastically slowed due to improvements in sewage treatment systems bordering the lakes and control of phosphorus discharges, new problems are surfacing. Phosphorus runoff from farmlands and toxic discharges are current pollution issues facing the Great Lakes National Program Office. This EPA office coordinates federal water quality research surrounding the Great Lakes. The EPA has identified more than 800 toxic chemicals in the Great Lakes ecosystem. These chemicals have caused many fish to be inedible. Environmental problems caused by cargo ships moving through the lakes and channels include oil spills and shoreline erosion. Perhaps the most emotionally charged issue is the proposed diversion of Great Lakes water to areas where water supplies are being depleted. Consumption and diversion significantly affect fisheries. Lower water levels reduce marshes and littoral waters vital to fish spawning and growth. Fish may also be killed when sucked into water intakes and diversion sends them out of the Great Lakes ecosystem, another possibly lethal move. The EPA is working to identify toxic hot spots by monitoring water, air deposition, sediments and fish tissue. (Mertz-PTT)
W90-04925

FIVE SISTER LAKES: A PROFILE.

Environmental Protection Agency, Washington, DC.
J. Lewis.
EPA Journal, Vol. 11, No. 2, p 5-6, March 1985.

Descriptors: *Lakes, *Great Lakes, *Canada, *St Lawrence Seaway, *Navigation canals, *Inland waterways, Ships, American Indians, Water boundary, History, Water resources development, Watercourses.

The Great Lakes form the largest surface expanse of freshwater in the world. All five of the Great Lakes are ranked among the fifteen largest lakes in the world. Completion of the St. Lawrence Seaway in 1959 connected the Great Lakes to form the largest freshwater transportation network in the world, stretching 2200 miles. More than 40 million people live and work in communities on the lakes' shores, comprising 15 percent of the U.S. population and 25 percent of Canadians. Wisconsin glaciation carved out the lake beds some 32,000 years ago. The lakes have been in their present form for only 7000 years. Various Indian tribes, including the Iroquois, Chippewa, Winnebago, Sauk, Menominee, and the Miami, have lived along the Great Lakes. The Westerner credited with discovering the Great Lakes was the French explorer, Samuel de Champlain, who stood on the shores of Lake Huron in 1615. Before the Industrial Revolution, the Great Lakes were considered 'seas of sweet water.' French domination of the lakes ended when the British defeated the French in the French and Indian Wars of 1754-1763. With the Treaty of Paris, in 1793, the Lakes were divided between the United States and British Canada. The War of 1812 spelled the final conflict in Great Lakes waters. Since then, the relationship between the U.S. and Canada has been peaceful. The Erie Canal opened in 1825 and freight traffic began moving around Niagara Falls via the Welland Canal since 1829. Lake Michigan was joined with the Mississippi River in 1848. Once-thriving industries, such as lumbering and fishing, are declining, however, due to depletion of natural riches. Tourism has become a thriving industry along these lakes. Urbanization, shipping and industrialization have taken their toll on the lakes. Erie, Ontario and Lake Michigan have suffered the most. Fortunately, the nearly pure waters of Lake Superior flow into all the other Great Lakes, so the potential for restored water quality does still exist. (Mertz-PTT)

W90-04926

HOW CANADA CONTROLS GREAT LAKES POLLUTION.

For primary bibliographic entry see Field 5G.
W90-04927

LEARNING IN THE GREAT LAKES 'LAB'.

Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
W. L. Richardson.
EPA Journal, Vol. 11, No. 2, p 11-12, March 1985.

Descriptors: *Lakes, *Great Lakes, *Limnology, *Water quality control, *Inland waterways, *Water resources development, *Water pollution control, Pesticides, Mercury, Polychlorinated biphenyls, DDT, Mathematical models, Ships, Navigation canals, Canada, US-Canada Boundary Waters Treaty, International Joint Commission, Phosphorus, Asbestos, Water law.

The macro-laboratory of the Great Lakes covers the five main lakes, the connecting channels and hundreds of feeder tributaries, embayments, and thousands of miles of shoreline. The experimental design includes man first as the perturber of the natural environment, then as one of the perturbed species and finally, as the scientist and manager. Few scientific observations were made until typhoid struck many Great Lakes towns in the early 1900s. Typhoid-related studies resulted from the 1909 U.S.-Canada Boundary Waters Treaty and the establishment of the International Joint Commission. Since the 1900s, pollutants have flowed into the Great Lakes from growing industrial centers on or near the shores. Other pollutants have fallen from the atmosphere or from ships moving along the St. Lawrence Seaway. Nuclear power plants discharge cooling waters into the lakes. Under Public Law 660, anti-pollution enforcement and comprehensive studies were initiated. The Great Lakes Illinois River Basin Project provided the first comprehensive water quality information for the lakes and was used in a landmark decision on diversions through the Chicago Ship Canal. Mathematical predictions forecast quality improvements that could be achieved if phosphorus inputs were reduced. This research led to a billion dollar cleanup program and vast improvements in Lake Erie. Research also led to the ban or control of DDT, mercury, PCBs, asbestos, and the pesticide toxaphene. Over 800 chemicals have been identified by research scientists studying Great Lakes fish samples. New studies are focusing on radionuclides and PCBs in Lake Michigan, heavy metals and PCB-like compounds in Monroe Harbor, Michigan, PCB mixtures and metals in Saginaw Bay and aromatic hydrocarbons in the near-shore waters of Lake Michigan. Most recently, a coordinated study has been started to investigate the Upper Great Lakes connecting channels. (Mertz-PTT)
W90-04928

THINKING ECOLOGICALLY IN LAKES PROTECTION.

L. Botts.
EPA Journal, Vol. 11, No. 2, p 13-14, March 1985.

Descriptors: *Limnology, *Lakes, *Great Lakes, *Water pollution, *Water pollution effects, *Chemical wastes, *Industrial wastes, Biological magnification, Wastewater treatment, Polychlorinated biphenyls, Pesticides, Fish, Lamprey, Trout, Clean Water Act, Dredging.

Algae are less abundant since the amount of phosphorus reductions have been implemented, but evidence is mounting that growing toxic contamination threatens the health of the Great Lakes ecosystem and its inhabitants. The Clean Water Act regulates the quality of effluent in direct discharges from municipal sewage treatment systems and industrial sources and the Clean Air Act can classify chemicals as hazardous if they cause harm from direct exposure. Neither law takes bioaccumulation in the food chain into account, although this is the way human health effects are most likely to be caused by toxic contamination of the Great Lakes.

Diversion of industrial wastes into publicly owned treatment plants causes the concentration of toxic chemicals in the sewage effluent. Since cleanup of conventional pollutants from the St. Louis River, the sea lamprey has begun to spawn there. Spread of the parasitic sea lamprey has resulted in the decline of the lakes' main predator, lake trout. Toxic chemical contamination also appears to be inhibiting the reproduction of lake trout. Dredging has been suggested as a means of cleaning up toxic hot spots, yet this causes resuspension of contaminants. It has recently been shown that gases excreted by bottom-feeding organisms can pass into the atmosphere through the water, recycling pollutants back to the atmosphere. Humans may receive toxic doses of PCBs, dieldrin, mirex, and chlordane by eating too many Great Lakes' fish. Officials suggest adults should limit their consumption of the fish and children and women of childbearing age should never eat the fish. Humans have caused most of the problems in the Great Lakes ecosystem, but we also have the greatest stake in solving them. (Mertz-PTT)
W90-04929

TOXICS: TODAY'S GREAT LAKES CHALLENGE.

L. K. Bulen.
EPA Journal, Vol. 11, No. 2, p 15-16, March 1985.

Descriptors: *Chemical wastes, *Water pollution sources, *Environmental protection, *Toxic wastes, *Water pollution control, *Lakes, *Great Lakes, Canada, Great Lakes Water Quality Agreement, Eutrophic lakes, Phosphorus, Biological magnification, Industrial wastes, Fish, Wastewater treatment.

The environmental challenge of this decade, and perhaps the remainder of this century, will be understanding and addressing the problems of toxic contaminants in our environment. Once pollutants are allowed to accumulate in the lakes, it may take decades or even generations for the lakes to cleanse themselves. Countless numbers and quantities of chemicals have been discharged into the Great Lakes. Eutrophication attracted considerable scientific and public concern, leading to the Great Lakes Water Quality Agreement, signed by the U.S. and Canada in 1972. The two countries spent billions of dollars to reduce phosphorus loadings from municipal and industrial discharges. The recent challenge is toxic chemical contamination. Bioaccumulation in aquatic organisms in the food chain has led to unsafe levels of toxins in many fish. We need to begin developing a comprehensive control strategy for toxic substances. Additional research is needed on rendering toxic materials harmless before their release into the environment. Pre-treatment technologies for industrial wastes sent to municipal wastewater treatment plants require expansion. Better yet, we should generate less toxic waste materials, promote recycling, and develop non-toxic substitutes. The challenge must be met by governments, industry, the scientific community and private citizens. (Mertz-PTT)
W90-04930

TOXICITY OF MICROCYSTIS SPECIES ISOLATED FROM NATURAL BLOOMS AND PURIFICATION OF THE TOXIN.

Ibaraki Univ., Ami (Japan). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 5C.
W90-04935

REQUIREMENT FOR A MICROBIAL CONSORTIUM TO COMPLETELY OXIDIZE GLUCOSE IN FERRIC-REDUCING SEDIMENTS.

Geological Survey, Reston, VA. Water Resources Div.
D. R. Lovley, and E. J. P. Phillips.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3234-3236, December 1989. 1 fig, 1 tab, 18 ref.

Descriptors: *Microbial degradation, *Biodegradation, *Iron, *Iron bacteria, *Potomac River, *Sedi-

ments, Fermentation, Methane, Methane bacteria, Alteromonas, River sediments, Maryland, Oxidation.

Geochemical studies have indicated that there are zones in aquatic sediments and aquifers in which either natural or contaminant organic compounds are completely oxidized to carbon dioxide with Fe(III) as the sole electron acceptor. The only Fe(III)-reducing microorganisms known to metabolize fermentable substrates, such as sugars and amino acids, are fermentative microorganisms that only reduce Fe(III) as a minor side reaction in their metabolism. Freshwater sediments in which Fe(III) reduction or methane production was the terminal electron-accepting process were obtained from the Potomac River, Maryland. Furthermore, freshwater sediments in which Fe(III) reduction was the predominant terminal electron-accepting process were artificially generated by adding an anaerobic slurry of a poorly crystalline Fe(III) oxide to the methanogenic sediments to provide 40 mmol of Fe(III) per liter of wet sediment. This inhibited methane production by over 95%. In various sediments in which Fe(III) reduction was the terminal electron-accepting process, 14C-glucose was fermented to 14C-fatty acids in a manner similar to that observed in methanogenic sediments. These results are consistent with the hypothesis that, in Fe(III)-reducing sediments, fermentable substrates are oxidized to carbon dioxide by the combined activity of fermentative bacteria and fatty acid-oxidizing, Fe(III)-reducing bacteria. The conclusion that organic matter is first fermented in Fe(III)-reducing sediments suggests that most of the Fe(III) reduction in sediments is catalyzed by Fe(III)-reducing microorganisms such as GS-15 and Alteromonas putrefaciens, that can completely oxidize fermentation products or aromatic compounds. (Mertz-PTT) W90-04936

RELATIVE SENSITIVITY OF CERODAPHNIA DUBIA LABORATORY TESTS AND POND COMMUNITIES OF ZOOPLANKTON AND BENTHOS TO CHRONIC COPPER STRESS. Miami Univ., Oxford, OH. Dept. of Zoology. For primary bibliographic entry see Field 5C. W90-04939

CHANGES IN CONCENTRATION OF LEAD AND CADMIUM IN WATER FROM THREE RIVERS IN DERBYSHIRE. Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station. For primary bibliographic entry see Field 5B. W90-04943

CLASSIFICATION OF WATER BEETLE ASSEMBLAGES IN ARABLE FENLAND AND POND COMMUNITIES OF SITES IN RELATION TO CONSERVATION VALUE. West of Scotland Agricultural Coll., Auchincruive, Dept. of Environmental Sciences. G. N. Foster, A. P. Foster, M. D. Eyre, and D. T. Bilton. Freshwater Biology FWBLAB, Vol. 22, No. 3, p 343-354, December 1989. 5 fig, 3 tab, 15 ref.

Descriptors: *Limnology, *Aquatic insects, *England, *Ditches, *Drainage ditches, Animal populations, Multivariate analysis, Cultivated lands, Insect populations, Water management, Water beetles.

Water beetles were recorded from 157 sites around the Wash, England, in 1986. Most sites were ditches in arable land. Eight main types of water beetle assemblage were identified by multivariate analysis. The habitats of these assemblages were characterized by measurement of a range of physical and chemical factors. Of the 130 species recorded, four were listed in the British Red Data Book and a further 35 were rated as Nationally Notable. Records from 1904 to 1938 for the same area indicated that only three species have been lost in the subsequent period of intensification of water management and arable farming. A rich water beetle fauna can thus survive in drainage systems in arable fen. Vegetation management was

important in maintaining the species quality score; proposed as a measure of conservation value, of larger ditches. However, management reduced the species quality of one type of assemblage associated with smaller ditches while another type of assemblage was found only in ditches subject to management. (Author's abstract) W90-04946

SEASONALITY AND SPATIAL VARIATION IN ABUNDANCE, BIOMASS AND ACTIVITY OF HETEROTROPHIC BACTERIOPLANKTON IN RELATION TO SOME BIOTIC AND ABIOTIC VARIABLES IN AN ETHIOPIAN RIFT-VALLEY LAKE (AWASSA). Waterloo Univ. (Ontario). Dept. of Biology. Z. Gebre-Mariam, and W. D. Taylor. Freshwater Biology FWBLAB, Vol. 22, No. 3, p 355-368, December 1989. 8 fig, 3 tab, 64 ref.

Descriptors: *Limnology, *Lakes, *Aquatic bacteria, *Plankton, *Africa, Ethiopia, Biomass, Aquatic productivity, Seasonal variation, Tropical lakes, Stratification, Nutrient requirements, Spatial distribution.

Seasonality and spatial variation in abundance, biomass and activity of heterotrophic bacterioplankton was studied in a tropical freshwater lake (Lake Awassa, Ethiopia). Variation in phytoplankton biomass and production, and several other limnological parameters, were also quantified. Bacterial number fluctuated between 3.88-8.33 times 10 to the 6 power/ml and biomass ranged between 68-125 mg carbon/cubic meter. No spatial variation was observed in these bacterial variables, although other limnological parameters showed vertical variation. Seasonal and vertical variation of heterotrophic bacterial activity were estimated from oxygen consumption, 14CO₂ dark uptake, and plate counts of colony forming units. All three methods showed vertical heterogeneity, with higher activity in the hypolimnion during the long stratification period (February-May). Oxygen consumption rate and plate counts showed seasonality. In spite of the low seasonality of climate in the tropics, several biological, chemical and physical variables were correlated with changes in bacterial variables. Wind and rainfall, and their effects on stratification and mixing, vertical distribution of nutrients and rate of primary production appeared to be the important parameters affecting heterotrophic bacterioplankton. (See also W90-04948) (Author's abstract) W90-04947

HETEROTROPHIC BACTERIOPLANKTON PRODUCTION AND GRAZING MORTALITY RATES IN AN ETHIOPIAN RIFT-VALLEY LAKE (AWASSA). Waterloo Univ. (Ontario). Z. Gebre-Mariam, and W. D. Taylor. Freshwater Biology FWBLAB, Vol. 22, No. 3, p 369-381, December 1989. 4 fig, 4 tab, 49 ref.

Descriptors: *Lakes, *Ethiopia, *Aquatic bacteria, *Africa, *Plankton, *Limnology, *Aquatic productivity, Growth rates, Oxygen requirements, Tropical lakes, Protozoa, Inorganic carbon, Spatial distribution, Seasonal variation, Grazing.

Heterotrophic bacterioplankton growth and production rates were estimated in a tropical lake (Lake Awassa, Ethiopia). Mean growth rates, determined by tritiated thymidine incorporation into DNA, frequency of dividing cells and increase in cell density varied between 0.013 and 0.014/h, corresponding to bacterial production of 1.16-1.12 mg carbon/cubic meter/hour. Heterotrophic bacterial production estimated from oxygen and inorganic carbon consumption in the dark were compared with these values. The oxygen method gave similar results, while values from dark carbon uptake were as much as 2.5 times higher. Although the different estimates of rates of bacterial production showed different patterns, the existence of spatial (vertical) and temporal (diel and seasonal) variation was demonstrated. Bacterial production was 13-41% of the net primary production and 10-30% of gross primary production. Bacterial grazing mortality rate was estimated from size-fraction-

ation and metabolic inhibitor experiments. Average grazing rates were between 0.34 and 3.77 mg carbon/cubic meter/hour, corresponding to 76-120% of the mean bacterial production rate. Organisms 1-12 micrometers in size, possibly mainly ciliates, were implicated as important bacterial grazers. (See also W90-04947) (Author's abstract) W90-04948

OCCURRENCE, CAUSES AND POTENTIAL CONSEQUENCES OF LOW ZOOPLANKTON TO PHYTOPLANKTON RATIOS IN NEW ZEALAND LAKES.

Otago Univ., Dunedin (New Zealand). Dept. of Zoology.

T. J. Malthus, and S. F. Mitchell. Freshwater Biology FWBLAB, Vol. 22, No. 3, p 383-394, December 1989. 3 fig, 1 tab, 91 ref.

Descriptors: *Lakes, *New Zealand, *Zooplankton, *Limnology, *Phytoplankton, Nitrogen, Nutrient requirements, Temperate lakes, *Cyanophyta.

New Zealand lakes are shown to have lower average zooplankton biomasses than north-temperate lakes of similar average phytoplankton biomass, expressed as cell volume or chlorophyll a, or similar average total phosphorus concentration, typically by a factor of 5 or more. Evidence suggests that the relatively low zooplankton biomasses of New Zealand lakes may be related to a tendency for the lakes to be dominated by large algae that are not directly available as food for zooplankton, with oligotrophic lakes in particular differing from north-temperate lakes in this respect. This difference in turn may be related largely to their mixing regimes. All of the New Zealand lakes are polymictic or monomictic, whereas the northern lakes used for comparison are mostly dimictic. Also, heterocystous cyanobacteria are favored by the low inorganic nitrogen concentrations that are typical of New Zealand lakes. Poor nutritional quality of the phytoplankton, relating to nitrogen limitation in many New Zealand lakes, might supplement the effects of cell size. Low exploitation of phytoplankton by zooplankton can be expected to produce a shift in the metabolism of New Zealand lakes towards the sediments. Among the potential consequences of this effect are increased hypolimnetic oxygen demand with increased susceptibility to development of large internal loads of nutrients, and consequently, increased sensitivity to accelerated eutrophication from any increase in external nutrient loads. (Author's abstract) W90-04949

EFFECTS OF NUTRIENTS AND GRAZERS ON PERIPHYTON PHOSPHORUS IN LAKE ENCLOSURES.

Waterloo Univ. (Ontario). Dept. of Biology. A. Mazumder, W. D. Taylor, D. J. McQueen, and D. R. S. Lean. Freshwater Biology FWBLAB, Vol. 22, No. 3, p 405-415, December 1989. 6 fig, 2 tab, 34 ref.

Descriptors: *Phosphorus, *Phytoplankton, *Limnology, *Eutrophication, *Nutrient requirements, *Light intensity, Fish, Fertilization, Amphipods, Midge, Periphyton, Predation.

Periphyton, measured as particulate phosphorus, growing on vertically oriented substrata (polyvinyl impregnated nylon) under different nutrient loadings, light intensities (exposures), and grazer communities was examined in eight lake enclosures (750 cubic meters) where nutrients (nitrogen and phosphorus) and planktivorous fish (1+ yellow perch) were added in a 2 x 2 factorial design. During the first 3 weeks of the experiment, there was a significantly higher accumulation of phosphorus into periphyton with fertilization, but fish addition had no effect. During the fourth to seventh weeks, addition of fish was associated with lower abundance of amphipods and chironomids and higher concentration of periphyton particulate phosphorus only at high exposures in the enclosures with fish. Exposure had a significant effect on periphyton particulate phosphorus. In the enclosures with fish, high abundance of nanoplankton

Field 2—WATER CYCLE

Group 2H—Lakes

reduced water transparency, and periphyton particulate phosphorus was lower in the deeper waters which may have been due to limitation by low light. Lower periphyton particulate phosphorus was also observed at the surface on sunny sides of enclosures without fish, and therefore with high water transparency. This pattern may have been due to inhibitory effects of high light intensity. Periphyton communities in the enclosures with fish had higher uptake rates for planktonic phosphorus, and lower rates of phosphorus release, suggesting that periphyton with high phosphorus demand may have high internal cycling of assimilated phosphorus. (Author's abstract)
W90-04950

BIOMASS AND OXYGEN DYNAMICS OF THE EPIPHYTE COMMUNITY IN A DANISH LOWLAND STREAM.
Copenhagen Univ., Hillerød (Denmark). Det Ferskvands-Biologiske Lab.
K. Sand-Jensen, D. Borg, and E. Jeppesen.
Freshwater Biology FWBLAB, Vol. 22, No. 3, p 431-443, December 1989. 9 fig, 3 tab, 36 ref.

Descriptors: *Rivers, *Denmark, *Epiphytes, *Limnology, *Algae, Biomass, Seasonal variation, Light intensity, Flow rates, Aquatic bacteria, Primary productivity, Photosynthesis, Sago pondweed, Oxygen.

We examined the abundance and oxygen metabolism of epiphytic organisms on the dominant macrophyte, *Potamogeton pectinatus*, in headwaters of the eutrophic River Sussa, in Denmark was examined. Microbenthic algae were abundant in the stream during spring and macrophytes during summer. The low macrophyte biomass in spring supported a dense epiphyte cover, whereas the high macrophyte biomass during summer had a thin epiphyte cover of 10 to 100-fold lower abundance per unit area of macrophyte surface. The epiphyte community was dominated by microalgae in spring and by heterotrophs, probably bacteria, during summer. This seasonal shift was shown by pronounced reductions of the chlorophyll a content (from 2.3% to 0.1-0.7% of organic dry weight), the gross photosynthetic rate (from 20-85 to 3-15 mg O₂/g organic dry weight/hour) and the ratio of gross photosynthesis to dark respiration in the epiphytic community (from 5-18 to 1). The reduced contributions of epiphytic microalgae correlated with reduced light availability during summer. Both the density and the photosynthetic activity of epiphytic algae were low on a stream area basis relative to those of microbenthic algae and macrophytes. Rapid variations in water velocity and extensive light attenuation in water and macrophyte stands probably constrained the development of epiphytic algae. The epiphyte community was more important in overall stream respiration, contributing about 10% to total summer respiration and about 20% to summer respiration within the predominantly heterotrophic microbial communities on sediments and macrophyte surfaces. (Author's abstract)
W90-04951

PERIPHYTON RESPONSES TO INVERTEBRATE GRAZING AND RIPARIAN CANOPY IN THREE NORTHERN CALIFORNIA COASTAL STREAMS.
California Univ., Berkeley. Dept. of Entomological Sciences.
J. W. Feminella, M. E. Power, and V. H. Resh.
Freshwater Biology FWBLAB, Vol. 22, No. 3, p 445-457, December 1989. 4 fig, 8 tab, 61 ref. NSF grant R11-8600411.

Descriptors: *California, *Lotic environment, *Periphyton, *Limnology, *Stream biota, Biomass, Grazing, Mayflies, Caddisflies, Ecology, Canopy, Aquatic insects, Benthos.

Field experiments were conducted to examine the impact of grazing invertebrates on periphyton biomass in 21 pools across three northern California coastal streams: Big Sulfur Creek, the Rice Fork of the Eel River, and Big Canyon Creek. Periphyton accrual on artificial substrate tiles was compared in each stream. Two treatments were used: those

elevated slightly above the stream bottom to reduce access by grazers (platforms) and those placed directly on the stream bottom to allow access by grazers (controls). Crawling invertebrate grazers (cased caddisflies and snails) were numerically dominant in each stream (86% of all grazers in Big Sulfur Creek, 61% in the Rice Fork, 84% in Big Canyon Creek). Platforms effectively excluded crawling grazers, but were less effective in excluding swimming mayfly grazers. Periphyton biomass on tiles was significantly lower on controls compared to platforms for the Rice Fork, an open-canopy stream, and Big Sulfur Creek, a stream with a heterogeneous canopy. In contrast, no grazer impact was found for Big Canyon Creek, a densely shaded stream. Here, extremely low periphyton biomass occurred for both treatments throughout the 60-day study. The influence of riparian canopy on periphyton growth (i.e. accrual on platforms), grazer impact on periphyton, and grazer abundance was examined for Big Sulfur Creek. As canopy increased (15-98% cover), periphyton biomass on platforms decreased. In contrast, canopy had little influence on periphyton accrual on controls; apparently, grazers could maintain low periphyton standing crops across the full range of canopy levels. The abundance of one grazer species, the caddisfly *Gumaga nigricula*, was highest in open, sunlit stream pools; abundance of two other prominent grazers, *Helicopsyche borealis* (Trichoptera) and *Centropilum convexum* (Ephemeroptera), however, was unrelated to canopy. (Author's abstract)
W90-04952

RESTING EGGS OF LAKE-DAPHNIA I. DISTRIBUTION, ABUNDANCE AND HATCHING OF EGGS COLLECTED FROM VARIOUS DEPTHS IN LAKE SEDIMENTS.
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Dept. of Ecophysiology.
G. R. Carvalho, and H. G. Wolf.
Freshwater Biology FWBLAB, Vol. 22, No. 3, p 459-470, December 1989. 4 fig, 5 tab, 41 ref.

Descriptors: *Glacial lakes, *Daphnia, *West Germany, *Limnology, Sediments, Epiphyta, Animal populations, Temperature effects, Seasonal variation, Sediment depth, Reproduction.

Resting eggs (ephippia) of *Daphnia galeata*, *D. hyalina*, *D. cucullata* and *D. galeata* x *D. hyalina* hybrids were collected from the upper 8 cm of sediments at various water depths from two glacial lakes in the Northern Federal Republic of Germany. The horizontal distribution of intact ephippia (i.e. those containing two apparently healthy eggs) was extremely patchy, with mean densities in the upper 8 cm ranging from 1325 to 113,907/square meter. Ephippial densities were greatest in sediments from deep waters. The highest densities of intact ephippia were in the upper 4 cm of sediment, with progressively fewer with increasing depth. A proportion of eggs obtained from sediments during autumn (September-November 1985) and spring (March-May 1986) were exposed to continuous light at three temperatures (6, 12, 20 °C), and the incidence of hatches recorded. Hatching success was consistently low (maximum 14.4%), with most hatching occurring at 12 °C. There was no significant difference between the hatching success of ephippia collected during autumn and spring. Decapsulation of ephippial eggs inhibited hatching. Hatching was highly synchronous within each treatment, and the pattern did not differ significantly with sediment depth, though hatching success was lower in deep sediments. A large reservoir of ephippia is present in lake sediments, of which a proportion may remain viable for many years. Periodic recruitment of hatchlings to the pelagic population may provide an important mechanism for the maintenance of genetic diversity in *Daphnia* populations, as well as affecting rates of evolutionary change. (See also W90-04954) (Author's abstract)
W90-04953

RESTING EGGS OF LAKE-DAPHNIA II. IN SITU OBSERVATIONS ON THE HATCHING OF EGGS AND THEIR CONTRIBUTION TO POPULATION AND COMMUNITY STRUCTURE.

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Dept. of Ecophysiology.
H. G. Wolf, and G. R. Carvalho.
Freshwater Biology FWBLAB, Vol. 22, No. 3, p 471-478, December 1989. 5 fig, 5 tab, 14 ref.

Descriptors: *Limnology, *Daphnia, *Glacial lakes, *West Germany, Seasonal variation, Animal populations, Physical properties, Genetic diversity, Epiphyta, Temperature, Oxygen.

To investigate the contribution of hatchlings from lake-*Daphnia* resting eggs (ephippia) to population and community structure, hatching was monitored in situ from April to November 1986 in two north German lakes. Hatching traps were placed on the sediments and the incidence, genetic and species composition of ephippial hatchlings determined twice-weekly. Hatching began in April after the thawing of ice, and continued for 3-4 weeks until the lakes stratified. There was no obvious relationship between the onset and duration of hatching and the environmental variables recorded, namely Secchi depth, surface temperature, temperature and oxygen concentration at the sediment-water interface. Among the hatchlings were *D. galeata*, *D. hyalina* and their interspecific hybrid. In the lake that contained overwintering animals the number of ephippial hatchlings was approximately one-third of the total number of juveniles present in the lake. In the second lake, no adults were recorded during winter and the population was probably founded by ephippial hatchlings alone. There was good agreement, in the short term, between the proportion of each species represented among hatchlings and the subsequent species composition in the lake. The hatchlings were genetically diverse, and alleles were representative of those alleles present in contemporary populations. (See also W90-04953) (Author's abstract)
W90-04954

FLOATING MEADOW EPIPHYTON: BIOLOGICAL AND CHEMICAL FEATURES OF EPIPHYTIC MATERIAL IN AN AMAZON FLOODPLAIN LAKE.
California Univ., Santa Barbara. Dept. of Biological Sciences.
D. L. Engle, and J. M. Melack.
Freshwater Biology FWBLAB, Vol. 22, No. 3, p 479-494, December 1989. 6 fig, 6 tab, 52 ref. NSF grant BJR 85-0794.

Descriptors: *Epiphytes, *Amazon River, *South America, *Lakes, *Algae, *Limnology, *Aquatic productivity, Grazing, Storm runoff, Biomass, Nutrient requirements, Carbon, Nitrogen, Phosphorus, Phytoplankton, Snails, Growth rates, Macrophytes.

Quantities and the chemical composition of epiphyton on the roots of floating aquatic macrophytes were measured in Lake Calado, an Amazon floodplain lake. Growth of epiphytic algae following physical disturbance and losses of epiphyton due to grazing and storms were investigated. Deposition of silt from invading river water decreased chlorophyll and nutrient content (%C, %N, %P) of epiphyton during rising water. N:P ratios of epiphyton indicated that proximity to the river increased supplies of phosphorus. Attached algal biomass per unit root tissue was higher overall during the falling water period, when light was greater, storms less frequent, and new host plant tissue produced more slowly. Epiphytic algal biomass at the margins of floating meadows exceeded that of the phytoplankton in the open water on a per unit area basis. Increases in attached algal chlorophyll ranged from two to ten-fold over one week. Artificial denudation of roots was followed by rapid regrowth of attached algae, leading, after one week, to four-fold increases in chlorophyll over the denuded areas. Wind-blown macrophytes experienced an episodic loss of 70% of epiphytic material in less than one hour. Particulate material lost from roots grazed by snails included root tissue and contained significantly more carbon than material lost from ungrazed roots. (Author's abstract)
W90-04955

RELATIVE IMPORTANCE OF TEMPORAL AND SPATIAL HETEROGENEITY IN THE ZOOPLANKTON COMMUNITY OF AN ARTIFICIAL RESERVOIR.

Natural History Museum and Inst., Chiba (Japan).
J. Urabe.

Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 1-6, November 1, 1989. 1 fig, 2 tab, 15 ref.

Descriptors: *Zooplankton, *Reservoirs, *Japan, *Limnology, Spatial distribution, Crustaceans, Seasonal variation, Cyclops, Daphnia, Water temperature, Temperature effects, Species composition.

If great horizontal heterogeneity exists in a given lake, the function and structure of the zooplankton community can not be understood accurately from analysis only of the temporal dimension. This study examined the relative importance of temporal and spatial variations in the zooplankton community of an artificial reservoir. Ogachi Reservoir is an impoundment of the Tama River located in the northwestern part of Tokyo, Japan. Zooplankton samples were collected monthly at three stations in Ogachi Reservoir during 1980, and the temporal and horizontal variations in the density of dominant taxa were evaluated by a standard 2-way ANOVA with random effects. The analysis revealed that horizontal is greater than temporal variation in the warm water season (> 18°C), whereas temporal variation is greater in the cold water season (< 18°C). In the cold water season, Cyclops vicinus predominated throughout the reservoir and a gradual downlake decline was found commonly in the density of all species. In the warm water season, Daphnia galeata and Bosmina longirostris predominated and the former showed a gradual decline from the dam to the head water in contrast with many species. Horizontal heterogeneity of the zooplankton community found in the warm water season seems to be associated with differences in site-specific conditions. (Mertz-PTT) W90-04956

ROTIFER OCCURRENCE IN RELATION TO WATER COLOUR.

Uppsala Univ. (Sweden). Limnologiska Institutionen.

B. Berzins, and B. Pejler.
Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 23-29, November 1, 1989. 1 fig, 8 ref.

Descriptors: *Dystrophic lakes, *Zooplankton, *Limnology, *Benthos, *Phytoplankton, *Rotifers, *Sweden, Species composition, Decomposing organic matter, Hydrogen ion concentration, Nutrient requirements.

Information on the distribution of 223 species of planktonic, periphytic and benthic rotifers from diverse waters in south and central Sweden was analyzed to reveal their relationships to the content of humulimnic substances, measured as mg Pt/L. Most rotifers have a very wide tolerance range against this factor. The majority of the planktonic species prefer a low content of humulimnic substances, and the non-planktonic rotifers mainly occurring in brown-colored water show, in addition, a preference for low pH. No connection with trophic level could be traced. (Author's abstract) W90-04957

THERMAL SUMMER CHARACTERISTICS OF LAKES AND PONDS ON DECEPTION ISLAND, ANTARCTICA.

Instituto Nacional de Limnologia, Santo Tome (Argentina).

E. C. Drago.
Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 51-60, November 1, 1989. 8 fig, 1 tab, 27 ref.

Descriptors: *Limnology, *Lakes, *Antarctica, Temperature effects, Stratification, Heated soil, Water temperature, Seasonal variation.

During January and February 1981, water temperature measurements were made in lakes and ponds of Deception Island, Antarctica. The depth of these waterbodies varies between 0.88 m and 36 m, with maximum surface areas of over 290,000 square meters. Some ponds freeze completely

during winter, and the lakes are covered by ice for 9-10 months of each year. The maximum ice thickness measured in early summer (December), did not exceed 0.5 m. Solar radiation and geothermal heating largely determined the thermal structure of these aquatic environments. The water temperature of tributary meltwater streams did not exceed 3°C, but the littoral waters reached 9°C. The bottom water temperatures of meromictic lake 5 (Irizar) was 12.3°C, and lake 9 was 19.9°C. These deep waters were heated from geothermal sources and it was possible that some ponds may have been also influenced by their proximity to hot soils. With the exception of the meromictic lakes, the aquatic environments studied here did not show a vertical stratification of temperature. It was not possible to establish a general thermal classification for the waterbodies of Deception Island. The interaction of the lacustrine morphology, solar radiation and vulcanism produced contrasting thermal features. Taking into account only the upper layers of meromictic lakes (mixolimnion), and emphasizing the fact that some ponds freeze completely during winter, the waterbodies of Deception Island would be classified as pleimictics. (Author's abstract) W90-04958

COMBINED EFFECTS OF CHLORINE AND AMMONIA ON LITTER BREAKDOWN IN OUTDOOR EXPERIMENTAL STREAMS.

Minnesota Univ., St. Paul. Dept. of Forest Resources.

For primary bibliographic entry see Field 5C.

W90-04959

LAKE PATZCUARO, MEXICO: RESULTS OF A NEW MORPHOMETRIC STUDY AND ITS IMPLICATIONS FOR PRODUCTIVITY ASSESSMENTS.

Universidad Michoacana de San Nicolas de Hidalgo, Morelia (Mexico). Lab. de Biología Acuática. C. Torres, L. G. Ross, and M. C. M. Beveridge.
Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 125-132, November 1, 1989. 2 fig, 3 tab, 29 ref.

Descriptors: *Sedimentation, *Limnology, *Lakes, *Mexico, *Bathymetry, Optimization model, Hydrograph analysis, Sedimentation rates, Mapping, Surveys.

Data for 25 morphometrical parameters describing the geomorphology of Lake Patzcuaro, Michoacan, Mexico have been derived from an up-to-date bathymetric map with contour-lines at 1.0 m intervals. Maximum depths were observed in the northern part of the lake, whereas considerable shallow areas were developing in the south. Insularity was continuously modified due to certain areas becoming part of the mainland and the appearance of new islands with increasing shallowness and man-made channels. The hydrographic survey was evaluated using the optimization model. An information value of 0.788 for 12 contour lines in the new bathymetric map is reported. The maximum depth contour line was 12 m. A 1944 report indicated a maximum depth of 15 m in the same area, and the figures for maximum depth vary among authors. It is clear that these values tend to decrease with time, possibly due to sedimentation rates. During the present survey, the echosounder registered an isolated maximum depth of 13 m only. It is difficult to compare the present map with the previous charts since all other previous attempts have been substantially incomplete. (Mertz-PTT) W90-04961

ECOLOGY OF THE LAMBRO RIVER.

Milan Univ. (Italy). Ist. di Biologia.

A. Zullini.

Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p 39-58, January-April 1989. 6 fig, 4 tab, 42 ref.

Descriptors: *Path of pollutants, *Benthos, *Italy, *Water pollution effects, *Nematodes, *Lotic environment, Biological samples, Chemical analysis, Animal populations, Pollution index, Species diversity.

The Lambro River is a small river in Northern Italy, 127 km long, that runs among mountains for almost 20 km, then forms a lake (Lago de Pusiano), after which it crosses one of the most crowded and industrialized areas in Italy, finally ending in the Po River. A number of chemical and biological analyses were made of 18 stations along the Lambro River in 1976-1979. This watercourse carries the largest load of water pollutants in Northern Italy to the Po River. 204 taxa have been identified in the entire Lambro River. To define the ecological condition of this river, the number of macrobenthic species, the Shannon diversity index, the extended biotic index and the nematode pollution index proved to be particularly useful. The nematode pollution index ranged from 11% at station 3 to 99.4% at station 18, and paralleled the pollution level very well. The percentage of Rhabditida is generally less than 20% in clean water.) Each station is characterized by a pair of dominant nematode species that represent more than 40% of the total nematodes. The entire river is divisible, from source to outlet, into the following four stretches: (1) Fictor ficator + Plectus cirratus, (2) Plectus cirratus + Paragolaimella bennettii, (3) Paragolaimella bennettii + Panagrolaimus hygrophilus. (Mertz-PTT) W90-04969

COMPARISON OF SOME PHOTOSYNTHETIC CHARACTERISTICS DURING THE GROWTH OF THREE AQUATIC MACROPHYTES IN TRASIMENO LAKE.

Perugia Univ. (Italy). Dipt. di Biologia Vegetale. G. Venanzi, S. Pasqualini, N. Pocceschi, and M. Antonielli.

Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p 59-71, January-April 1989. 2 fig, 2 tab, 36 ref.

Descriptors: *Limnology, *Photosynthesis, *Lakes, *Italy, *Macrophytes, Aquatic plants, Myriophyllum, Aquatic productivity, Enzymes, Seasonal variation.

Three typical macrophytes from Trasimeno Lake (Italy), Ceratophyllum demersum, Myriophyllum spicatum and Lemna minor were studied. The following photosynthetic parameters were examined: Ribulose diphosphate carboxylase, phosphoenolpyruvate-carboxylase, malic acid and pigment content. In M. spicatum and C. demersum, ribulose diphosphate carboxylase is the principal carboxylating enzyme and the ribulose diphosphate carboxylase/phosphoenolpyruvate-carboxylase ratio was always less than one. In L. minor, the ratio was greater than one only in the spring, while in the late summer and autumn it was less than one. The activity of these enzymes varies considerably during the developmental cycle with the maximum occurring in February for C. demersum, in March for M. spicatum, and in May for L. minor. The malic acid content varies significantly during the developmental cycle and the minimum values correspond to the maximum activity levels of phosphoenolpyruvate-carboxylase; chlorophyll and carotenoid contents, different in submerged plants (C. demersum and M. spicatum) or floating plants (L. minor), showed seasonal variations. This study shows that aquatic plants cannot be considered either typical C3 or typical C4 plants; it can be seen that, in light of the seasonal variations of the carboxylating enzymes, the plants are able to modify the type of photosynthetic fixation of carbon used according to environmental conditions. (Mertz-PTT) W90-04970

RESEARCH ABOUT THE MESOLOGICAL FACTORS OF THE PRINCIPAL SARDINIAN PONDS VISITED BY PHENOCOPITERUS RUBER ROSEUS (PALLAS), AND THE BEST CONDITIONS SELECTED BY IT. (CARATTERISTICHE MESOLOGICHE DEI PRINCIPALI 'STAGNI' SARDI VISITATI DA PHENOCOPITERUS RUBER ROSEUS (PALLAS), ED OPTIMUM DELLE CONDIZIONI DA ESSO RICERCATE).

Cagliari Univ. (Italy). Ist. di Zoologia ed Anatomia Comparata.

Field 2—WATER CYCLE

Group 2H—Lakes

A. M. Demaris.
Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p 89-119, January-April 1989. 14 tab, 34 ref. English summary.

Descriptors: *Ponds, *Italy, *Limnology, *Biological samples, *Water birds, Monitoring, Flamingos, Benthos.

During research on the Sardinian Pond population of *Phoenicopus ruber roseus* (Pallas) and the benthonic zoocenosis, water samples were taken and analyzed. The ponds studied were located in three important districts of Sardinia (Italy): near Cagliari, near Oristano, and near S. Antioco (district C). Five of these ponds illustrate Ramsar's Convention (which says that qualitative knowledge of aquatic birds should be valued as ecological indicators of environmental quality). The results of a monthly analysis are presented in ten tables. Although the samples were taken in 1978, new analyses of controls confirmed that the original mesological conditions have not changed, and that these comply with Italian law concerning the protection of waters from pollution. Using data from a Flamingo census made in 1978 and water quality information, the author speculates that the best mesological conditions are selected by *Phoenicopus ruber roseus* and by its prey-specimens. The spatial niche of this bird is discussed. (Mertz-PTT) W90-04971

FEATURE AND DYNAMIC OF THE ZOOPLANKTON OF A LAKE OF CENTRAL ITALY (LAKE ALBANO, LATIUM), (STRUTTURA E DINAMICA DELLO ZOOPLANKTON DI UN LAGO VULCANICO DELL'ITALIA CENTRALE (LAGO ALBANO, LAZIO)).

Rome Univ. (Italy). Dept. of Animal and Human Biology.
F. G. Margaritora, E. Stella, and O. Ferrara.
Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p 131-147, January-April 1989. 6 fig, 1 tab, 33 ref. English summary.

Descriptors: *Limnology, *Lakes, *Italy, *Zooplankton, *Species composition, *Spatial distribution, Rotifers, Waterfleas, Copepods, Daphnia, Cyanophyta, Algae, Seasonal variation.

A series of investigations recently performed on Lake Albano, was carried out from June 1986 to May 1987 to compare the present zooplankton community to that described in previous studies. Six stations were chosen for the monthly samplings, in the center of the lake and at the littoral zone. Zooplankton species included 11 species of rotifers, 4 cladocerans, and 2 copepods. The composition of the community remained substantially unchanged when compared with the past situation; changes were observed in density, distribution and dynamic of some of the most important species, probably in relation to development of the blue-green algae that tend to grow in the summer at depths of 15 and 25 meters. The copepods remained the dominant group all year; *Eudiaptomus* being particularly disturbed by the algae; the carnivorous *Cyclops* was favored by the high density of rotifers. Cladocerans were reduced in density; the presence of the *Cyanophyceae* had a negative effect on the reproduction and development of *Daphnia*. Analysis revealed a peculiarity to the distribution of the mesoplanktonic species: the adults of *Daphnia*, *Diaphanosoma* and copepods were frequently sampled in the upper layers and in the littoral waters, unlike their usual distribution. The data suggest a change in the zooplanktonic community that is probably due to the trophic modification in the lake. (Mertz-PTT) W90-04972

COMPOSITION OF THE INVERTEBRATE FAUNA IN LAKE MONTEROSI (CENTRAL ITALY), 1975-1977, (COMPOSIZIONE DELLA FAUNA AD INVERTEBRATI DEL LAGO DI MONTEROSI (ITALIA CENTRALE) NEGLI ANNI 1975-1977).

Rome Univ. (Italy). Dept. of Animal and Human Biology.
M. Bazzanti, O. Ferrara, and L. Mastrantuono.
Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p

149-160, January-April 1989. 3 fig, 2 tab, 16 ref. English summary.

Descriptors: *Lakes, *Italy, *Invertebrates, *Eutrophication, *Macrophytes, *Limnology, *Benthos, Zooplankton, Aquatic plants, Water quality, Ecosystems.

The composition of the invertebrate fauna of Lake Monterosi, Italy (surface area: 0.32 square km and maximum depth: 6.2 m) during 1975-1977 was studied in order to assess lacustrine trophic changes with respect to the results of a previous study carried out in 1963-1966. The lake showed a high transparency, a relatively high oxygen content, and an increase of aquatic macrophytes on the bottom. The pelagic zooplankton showed no marked qualitative and quantitative modifications, with the exception of a numerical increase in the rotifers and particularly of *Keratella quadrata*, typical of eutrophic waters. In contrast, a replacement of several species was observed in the littoral zooplankton in relation to the increase in aquatic vegetation. The benthic fauna were still composed both of taxa inhabiting organically enriched sediments and of organisms associated with macrophytes. The results indicated no relevant changes in the water quality of the lake, which seems to be subject to a slow process of eutrophication. (Author's abstract) W90-04973

PROFUNDAL MARCOBENTHOS OF THE ARTIFICIAL LAKE CAMPOTOSTO (ABRUZZO, CENTRAL ITALY), (MACROBENTHOS PROFONDO DEL LAGO ARTIFICIALE DI CAMPOTOSTO (ABRUZZO, ITALIA CENTRALE)).

Rome Univ. (Italy). Dept. of Animal and Human Biology.
M. Bazzanti, M. Seminara, and C. Tamorri.
Rivista de Idrobiologia RIIDBN, Vol. 27, No. 1, p 161-175, January-April 1989. 5 fig, 1 tab, 34 ref. English summary.

Descriptors: *Limnology, *Benthos, *Eutrophication, *Lakes, *Italy, *Artificial lakes, *Macroinvertebrates, Oligochaetes, Midges, Nematodes, Mollusks, Trophic level, Ecology, Environmental quality.

A study on the profundal macrobenthos of the artificial Lake Campotosto, Italy was carried out during the summer and early autumn of 1983 and 1984, with the aim of contributing to the knowledge of the composition and structure of this community in artificial lakes. A total of 39 taxa, mostly belonging to oligochaetes (17) and chironomids (15), was collected in 5 sampling stations. The most abundant groups were oligochaetes and secondarily, chironomids, nematodes and bivalves. Densities and biomasses of the total fauna were different among the stations and were generally high (values up to 37,645 individuals/square meter and 65.151 g/square m, respectively). The presence of high quantities of benthos, the dominance of *Limnodrilus* and *Chironomus* gr. plumosus, and the feeding habits of the benthic elements all clearly indicated eutrophication of the sediments. This phenomenon is in strong contrast with the trophic level of the overlying waters, which showed an oligotrophic status (low total P and relatively high oxygen contents). The results indicate the importance of the profundal macrobenthos in performing a correct evaluation of the comprehensive environmental quality of the lake. (Author's abstract) W90-04974

PHYTOPLANKTON OF BARBA, FRAIJANES, AND SAN JOAQUIN LAKES, COSTA RICA (FITOPLANCTON DE LAS LAGUNAS BARBA, FRAIJANES Y SAN JOAQUIN, COSTA RICA).

Costa Rica Univ., San Jose.
G. U. Villalobos.
Revista de Biologia Tropical RBTCAP, Vol. 36, No. 2B, p 471-477, November 1988. 3 fig, 1 tab, 17 ref. English summary.

Descriptors: *Phytoplankton, *Lakes, *Limnology, Costa Rica, Species composition, Altitude, San Joaquin Lake, Fraijanes Lake, Barba Lake.

The phytoplankton in three small lakes at different altitudes and climates in Costa Rica—San Joaquin (10 m), Fraijanes (1660 m) and Barba (2840 m)—was studied. They are similar in area and basic morphology. A total of 132 different taxa were found. The number of taxa decreased at higher altitude: San Joaquin (71), Fraijanes (63) and Barba (31). Chlorophyta was the richest group in the three lakes. Substantial differences were detected in the composition among the lakes. The global similarity at the lowest taxonomic level separation was 41.7%. San Joaquin and Fraijanes are the most similar lakes with a 17% Jaccard similarity. (Author's abstract) W90-04992

SEASONAL AND LONG-TERM VARIATIONS OF DISSOLVED SOLIDS IN LAKES AND RESERVOIRS.

Manhattan Coll., Bronx, N.Y. Dept. of Environmental Engineering and Science.
D. J. O'Connor.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1213-1234, December 1989. 10 fig, 15 ref.

Descriptors: *Water chemistry, *Path of pollutants, *Water pollution sources, *Dissolved solids, *Lakes, *Reservoirs, Seasonal variation, Salinity, Mathematical models, Hydrologic budget, Evaporation, Detention time, Runoff, Bays, Temporal distribution.

Increasing concentration of dissolved solids due to irrigation returns, industrial uses, and road-deicing practices has been observed in many bodies of water. The seasonal and long-term variations of dissolved solids in lakes and reservoirs were analyzed in accordance with the hydrologic-balance and mass-balance equations. The volume and surface area were expressed as power functions of depth that yield analytical solutions for the long-term analysis. The equation defining the water elevation and volume and surface area were expressed as power functions of depth that yield analytical solutions for the long-term analysis. The equation defining the water elevation and volume was approximated by exponential functions that simplify the solution of the mass-balance equation of the dissolved solids. For the intermediate and seasonal time scales, periodic and exponential functions define the hydrologic components, providing the forcing functions for the dissolved solids equations. For both cases, an exponential residence time transforms the mass-balance equation, leading to analytical solutions. Given the mass and volume, the concentration follows. The temporal variations of dissolved solids, calculated by the associated mass and volumetric equations, are compared to the observed change in salinity in lakes and reservoirs of various geophysical and hydrological characteristics. (Author's abstract) W90-05028

DAILY AVERAGE VALUE OF UN-IONIZED AMMONIA FROM FIELD MEASUREMENTS.

R. H. French, and J. J. Cooper.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1264-1268, December 1989. 1 fig, 1 tab, 7 ref, append.

Descriptors: *Water analysis, *Water chemistry, *Ammonia, *Lake Mead, *Water quality, Ions, Remote sensing, Monitoring, Hydrologic data collections, Hydrogen ion concentration, Temperature effects, Seasonal variation, Diurnal distribution, Conductivity, Temporal distribution.

A technique was developed to transform a calculated value of the fraction of un-ionized ammonia for any time during a 24-hr period to the daily average value of the fraction of un-ionized value for Las Vegas Bay, an arm of Lake Mead. It was hypothesized that during any 24-hr period in the critical water quality period of April 1 to September 30 receiving water temperature, pH, and ionic strength vary in a regular and predictable fashion. This was confirmed with data collected from a remote data sonde placed in Las Vegas Bay at a fixed station and at various times during the period

in question. The ratio of daily average fraction of un-ionized ammonia to daily average fraction of ionized ammonia was found to be a function of the time of day with the average value occurring at approximately noon and midnight. Tables show that during the months of April to September water temperature, pH and conductivity vary over a 24-hr period such that the value of the ratio is a predictable function of time in Las Vegas Bay. A method for adjusting historical un-ionized ammonia data to the daily average value indicates that the daily average value of un-ionized ammonia occurs in the period 1000 to 1400 hr after midnight (Pacific Daylight Time). This technique should be useful in other lakes and streams where water quality is affected by ammonia inputs. (Geiger-PTT)

W90-05031

MEASUREMENT OF UPWELLING FLOW FROM AIR DIFFUSER.

Jones and Stokes Associates, Inc., Sacramento, CA.

For primary bibliographic entry see Field 5G. W90-05032

MASS TRANSFER PROPERTIES OF THE BENTHIC BOUNDARY LAYER WITH AN APPLICATION TO OXYGEN FLUXES.

Sveriges Meteorologiska och Hydrologiska Inst., Norrköping.
L. Rahm, and U. Svensson.
Netherlands Journal of Sea Research NJSRBA, Vol. 24, No. 1, p. 27-35, October 1989. 8 fig, 1 tab, 24 ref.

Descriptors: *Mass transfer, *Oxygen transfer, *Limnology, *Boundary layers, *Sediment-water interfaces, Benthos, Diffusion, Marine sediments, Dissolved solids, Mathematical models, Flow velocity, Flow friction, Turbulent flow.

The diffusive transfer of dissolved substances between the sediments and the benthic boundary layer is studied by use of a mathematical model. It includes a two-equation turbulence model for the major part of the benthic boundary layer and the interior, while a low Reynolds number one-equation turbulence model with prescribed length scale is applied to the viscous sublayer in order to resolve the latter layer. This is because the main resistance in the transfer of a substance between the sediments and the benthic boundary layer is found in this sublayer. The flux rates are calculated by use of a diffusion equation where the vertical dependence of exchange coefficient is determined by the two turbulence models. The present model is limited to hydrodynamically smooth bottoms. The predicted flux rates are in good agreement with independent estimates of scalar fluxes from boundaries for both low and high Prandtl/Schmidt numbers. The time-dependent model also yields detailed concentration and velocity profiles together with turbulence parameters. (Author's abstract) W90-05033

ROLE OF WATER RETAINING SUBSTRATA ON THE PHOTOSYNTHETIC RESPONSE OF THREE DROUGHT TOLERANT PHOTOTROPHIC MICRO-ORGANISMS ISOLATED FROM A TERRESTRIAL HABITAT.

Amsterdam Univ. (Netherlands). Lab. voor Microbiologie.
B. de Winder, H. C. P. Matthijs, and L. R. Mur.
Archives of Microbiology AMICW, Vol. 152, No. 5, p. 458-462, October 1989. 3 fig, 1 tab, 20 ref.

Descriptors: *Algae, *Cyanophyta, *Chlorophyta, *Colonization, Drying, Photosynthesis, Oscillatoria, Water retention, Terrestrial habitats.

The water requirements of two drought tolerant *Oscillatoria* type cyanobacteria and one green alga were estimated by their ability to photosynthesize (carbon dioxide fixation) under conditions of subsaturating water supply. Fixation was zero in desiccated samples. Equilibration with solely water-saturated air did not result in any photosynthesis. However, certain properties of the physical environment of the samples could re-establish photo-

synthetic activity. These properties were elected by choosing membrane filters with different water retention characteristics as supporting substrata for the test samples in the dehydration and rehydration steps. Rehydration enabled the recovery of photosynthesis of desiccated samples only on the filters with good water retention, the filters with bad water retention were ineffective. The *Oscillatoria* strains showed photosynthesis instantaneously and revealed nearly 100% viability. In contrast, rewetted cells of the green alga showed only 35% viability and the recovery of photosynthesis occurred only after 5 h. These differences reflect natural environmental conditions: cyanobacteria are the first colonizers in the barren sand, whereas green algae can only start to colonize after improvement of the water retention properties brought about by the pioneering cyanobacteria. (Author's abstract) W90-05034

VALIDITY OF THE EMPIRICAL CONVERSION FACTORS FOR ASSESSING BACTERIAL PRODUCTION FROM 3H THYMIDINE INCORPORATION RATES.

Toulouse-3 Univ. (France). Lab. d'Hydrobiologie.
P. Lavandier, and F. Faure.
Annales de Limnologie ANLIB3, Vol. 25, No. 2, p. 93-100, 1989. 4 fig, 3 tab, 24 ref.

Descriptors: *Limnology, *Aquatic bacteria, *Bacterial physiology, *Nucleic acids, Culturing techniques, Growth, Lakes, Biomass.

Empirical factors for converting 3H thymidine incorporation into bacterial production were determined from samples taken in a mesotrophic lake. Twenty five diluted water cultures were conducted at 'in situ' temperature (4-22 degrees C) from April 1987 to February 1989. The conversion factors varied through the year; the average conversion factor was 6.29×10^3 to the 9th power cells ($2-10.7$) per nanomole of thymidine incorporated into cold TCA precipitate and 7.18×10^3 to the 9th power cells ($3.47-10.7$)/nmol, when corrected for the increase in cell biomass which occurred during the incubations. The validity of these factors, higher than the theoretical conversion factors values, were analyzed considering the diluted water culture conditions and the data analysis methods. When there is a discrepancy between the curves of the incorporation rates and cell numbers, the conversion factors may greatly influence the results. Even if the whole growth period is considered, the results depend on the frequency of the measurements for determining exactly the end of the lag period and overall the beginning of the stationary phase. In fact, thymidine incorporation continues after the growth in number ceases. (Author's abstract) W90-05035

LONGITUDINAL STUDY OF ZOOPLANKTON ALONG THE LOWER ORINOCO RIVER AND ITS DELTA (VENEZUELA).

Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana.
For primary bibliographic entry see Field 2E. W90-05036

COMPOSITION, DISTRIBUTION AND BIOMASS OF BENTHIC MACROPHYTE COMMUNITIES FROM LAKE BACIVER, A SPANISH ALPINE LAKE IN THE CENTRAL PYRENEES.

Consejo Superior de Investigaciones Cientificas, Gerona (Spain). Centro de Estudios Avanzados de Blanes.
E. Ballesteros, C. Gacia, and L. Camarero.
Annales de Limnologie ANLIB3, Vol. 25, No. 2, p. 177-184, 1989. 3 fig, 6 tab, 42 ref.

Descriptors: *Spain, *Oligotrophic lakes, *Mountain lakes, *Limnology, *Macrophytes, Benthos, Water depth, Acid lakes, Biomass, Ice-scour, Sediments.

Species composition, distribution and biomass of benthic macrophyte communities have been studied in a high mountain, oligotrophic, softwater lake

from the Central Pyrenees. Isoetids (*Isoetes lacustris* L., *Isoetes setacea* Lam., *Subularia aquatica* L. and *Eleocharis acicularis* (L.) Roemer & Schultes) are the dominant macrophytes in areas over 2-3 meters in depth. Natopotamids (*Spartanium angustifolium* Michx.) are restricted to shallow waters. Algae (*Nitella gracilis* (Smith) Agardh) only predominate in deep waters. Three main communities have been distinguished: the *Spartanium angustifolium* community (160 g dwt/sq m), the *Isoetes lacustris* community (120-460 g dwt/sq m) and the *Nitella gracilis* community (11 g dwt/sq m). Biomass differences between shallow and deep water *Isoetes* populations have been attributed to ice-scour stress. Neither irradiance nor slope can explain the lower boundaries observed in the distribution of vascular plants; sediment features may be responsible for them. Mean lake macrophyte biomass amounts to 140 g dwt/sq m (20 g C/sq m), a very high value if compared with boreal lakes with similar limnological characteristics. (Author's abstract) W90-05037

PHOSPHATE UPTAKE BY EUKARYOTIC ALGAE IN CULTURES AND BY A MIXED PHYTOPLANKTON POPULATION IN A LAKE: ANALYSIS BY A FORCE-FLOW RELATIONSHIP.

Institut fuer Limnologie, Mondsee (Austria).
R. Falkner, and G. Falkner.
Botanica Acta BOACEJ, Vol. 102, No. 4, p. 283-286, November 1989. 4 fig, 1 tab, 12 ref.

Descriptors: *Phosphates, *Algae, *Phytoplankton, *Limnology, Culturing techniques, Lakes, Conductivity, Force-flow relationship.

The phosphate uptake behavior of monospecific cultures of green algae in the laboratory and of mixed phytoplankton populations in a mesotrophic lake has been analyzed with the aid of a force-flow relationship. This analysis yields two parameters: (1) A conductivity coefficient, that characterizes the activity of the phosphate uptake system; (2) An external threshold phosphate concentration, below which uptake of phosphate is excluded on energetic grounds. When the phosphate concentration lies below the threshold value, the algae show an activation of the uptake system, reflected in an increase in the conductivity coefficient. Correspondingly, excess phosphate above the threshold value leads to a diminution of the conductivity. Using this simple analysis, phosphate discharge into lake water may be readily monitored. (Author's abstract) W90-05039

WATERSHED ACIDIFICATION MODELS USING THE KNOWLEDGE-BASED SYSTEMS APPROACH.

National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5C. W90-05043

ATP AS AN INDEX OF PHYTOPLANKTON PRODUCTIVITY. THE CHL A/ATP QUOTIENT.

Akademiya Nauk Estonskoi SSR, Tartu. Inst. Zoologii i Botaniki.
T. Noges.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 74, No. 2, p. 121-133, 1989. 5 fig, 3 tab, 30 ref.

Descriptors: *Limnology, *Estuaries, *Phytoplankton, *Adenosine triphosphate, *Eutrophic lakes, *Chlorophyll a, *USSR, Seasonal variation, Productivity, Diatoms, Comparison studies, Baltic Sea, Phosphorus, Nitrogen.

The seasonal changes in the adenosine triphosphate (ATP) and chlorophyll a (Chl a) concentrations in two eutrophic lakes (Lake Peipus, Lake Võrtsjärv; Estonia) were studied in the course of two years. Comparative measurements were performed in the Baltic Sea. The main task was to examine how the ATP content of the water characterizes the func-

Field 2—WATER CYCLE

Group 2H—Lakes

tional state of the phytoplankton community. Primary production, total phosphorus and total nitrogen were measured as supplementary parameters. The under-ice bloom in Lake Vortsjarv was also observed. The under-ice bloom, consisting mainly of the diatom *Melosira islandica* spp. helvetica, started at the bottom of the water body and spread over the whole water column in a few days. The ATP content correlated well with changes in the Chl a concentration of the bottom water, but in the uppermost regions of the water column no correlation was found. Obviously most of the cells had died before reaching the surface layers. Seasonal observations showed an accumulation of 'dead' chlorophyll in autumn. The Chl a/ATP ratio increased in the following order: sea; eutrophic lake; hypereutrophic lake. The values of the index increased exponentially as the phytoplankton standing stock increased. (Author's abstract)
W90-05047

PERCH, PERCA FLUVIATILIS L., IN SMALL LAKES: RELATIONS BETWEEN POPULATION CHARACTERISTICS AND LAKE ACIDITY.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5C.
W90-05048

ABSORPTION COEFFICIENT OF PARTICULATE MATTER IN LAKE HARUNA.
Gunma Univ., Maebashi (Japan). Faculty of Education.
A. Sugawa, and K. Yajima.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p 219-225, 1989. 6 fig, 2 tab, 12 ref.

Descriptors: *Limnology, *Particulate matter, *Chlorophyll a, Light absorption, Detritus, Seasonal variation, Turbulent flow, Japan, Plankton.

The absorption coefficient of particulate matter at a particular wavelength is expressed by the sum of the absorption coefficients of detritus and phytoplankton at that wavelength. The absorption coefficient of phytoplankton is the product of the specific absorption coefficient of chlorophyll a and the chlorophyll-a concentration at a given depth. The value of the absorption coefficient of chlorophyll a in the region 400-500 nm has a maximum at 440 nm. Therefore, in Lake Haruna, Japan, the absorption coefficient of particulate matter at 440 nm and the chlorophyll a concentration were measured monthly (July through November 1987), and the corresponding coefficients were obtained for detritus and plankton. Except for the November sample, the value for the particulate matter absorption coefficient was much larger at a depth of 12 m than at 0, 4, and 8 m. This may have been caused by turbulence, which in turn may have been affected by bottom current. For the same sun angle, absorbance by particulate matter in the lake water increased with depth. (Shidler-PTT)
W90-05054

ORGANIC CARBON BUDGET IN A HEADWATER STREAM AT URATAKAO, (IN JAPAN).
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Environmental Science and Conservation.
T. Yasuda, H. Ichikawa, and N. Ogura.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p 227-234, 1989. 5 fig, 3 tab, 23 ref. English summary.

Descriptors: *Nutrient budget, *Organic carbon, *Japan, *Carbon cycle, Particulate matter, Runoff, Litter, Algae, Seasonal variation, Stream discharge.

The annual organic carbon budget was estimated from 1984 to 1985 in Kogesawa Stream (one of head waters of the Tama River) at Uratakao, Japan. Total organic carbon input to the section was 1,960 kgC. Geological input of DOM (Dissolved Organic Matter) and FPOM (fine particulate organic matter) accounted for 88% of the total input. Biological inputs amounted to 228 kgC as

algal primary production (100 kgC), and terrestrial litter fall and lateral movement (128 kgC). Outputs of DOM and FPOM were 1,200 kgC and 620 kgC, respectively. FPOM outflow was 1.3 times greater than inflow. Community respiration as biological output (77 kgC) was 77% of primary production, and 34% of primary production and litter input. Residence and run-off of organic matter were largely influenced by stream water discharge. During low flow, including periods of autumnal leaf fall and spring algal high production, net gain of organic carbon was positive or nearly zero. However, during only 1 to 2 months of high discharge, organic carbon that accumulated at the stream bed flowed downstream. (Author's abstract)
W90-05055

SEDIMENTARY ENVIRONMENTS INFERRED FROM LITHOFACIES OF THE LAKE BIWA 1400 M CORE SAMPLE, JAPAN, (IN JAPANESE).
Kyoto Univ., Beppu (Japan). Geophysical Research Station.
For primary bibliographic entry see Field 2J.
W90-05057

RESPIRATORY RESPONSES OF AQUATIC INSECTS TO LOW OXYGEN CONCENTRATION, (IN JAPANESE).
Tokyo Metropolitan Univ. (Japan). Dept. of Biology.
F. Hayashi.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p 255-268, 1989. 5 fig, 61 ref. English summary.

Descriptors: *Limnology, *Aquatic insects, *Oxygen requirements, *Habitats, Adaptation, Caddisflies, Dobsonflies, Dragonflies, Mayflies, Stoneflies, Beetles, Insects.

Oxygen is less available in water than in air because of its low solubility and heterogeneous distribution. Larvae of Ephemeroptera, Odonata, Plecoptera, Megaloptera, Trichoptera, and aquatic Diptera generally use dissolved oxygen for respiration. In this review, respiratory responses of these aquatic insects to low oxygen conditions are compared in relation to their habitat differences. The species inhabiting relatively low oxygen environments regulate their respiratory rates against hypoxia, but the respiratory rates of riffle-dwelling species are decreased with the decline of oxygen concentration. To compensate for respiratory rates, the following are important characteristics: (1) gill development, (2) gill beating, (3) respiratory movement (undulation or ventilation), (4) respiratory pigments (erythrocrucorin or hemoglobin), (5) anaerobic metabolism, (6) bimodal breathing (aquatic and aerial respirations), and (7) microhabitat shift. In order to further discuss the speciation processes that produce diverse respiratory characteristics, much more research is needed, especially to find variation in respiratory characteristics within a population or between populations and to examine whether the variation has a genetic basis or not. (Author's abstract)
W90-05058

ARSENIC GEOCHEMISTRY OF RAPIDLY ACCUMULATING SEDIMENTS, LAKE OAHE, SOUTH DAKOTA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05085

PERIPHYTON EFFECTS ON ARSENIC TRANSPORT IN WHITEWOOD CREEK, SOUTH DAKOTA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-05088

VOLUNTEER LAKE MONITORING PROGRAM, 1987, VOLUME IV: WEST-CENTRAL ILLINOIS REGION.
Illinois State Environmental Protection Agency,

Springfield. Div. of Water Pollution Control.
J. Hawes, N. Weatherby-Thomas, and V. Wood.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-127690. Price codes: A06 in paper copy, A01 in microfiche. Report No. IEPA/WPC/88-016d, September 1988. 94p, 2 fig, 5 tab, 24 ref, 2 appendix.

Descriptors: *Illinois, *Lakes, *Water quality, *Public participation, *Monitoring, Water depth, Secchi disks, Field tests, Transparency, Trophic level.

This report is Volume IV of a series of seven reports summarizing Illinois EPA's 1987 Volunteer Lake Monitoring Program (VLMP). It provides a program overview, a summary of 1987 VLMP lakes in West-Central Illinois, including a discussion of lake characteristics, volunteer participation, and a ranking of lakes on a regional basis. West-Central Illinois results are compared to statewide statistics. Lake assessment information from the Illinois Water Quality Report 1986-1987 for West-Central VLMP lakes is provided and briefly discussed. Lake/watershed management strategies are described. Thirty-five volunteers recorded total depth, Secchi disk transparency, and field observations for 20 lakes in West Central Illinois between May and October, 1987. Included were 10 dammed-stream impoundments and one strip mine lake. Average transparencies ranged from 13-91 inches. Twenty percent of the lakes exhibited average transparencies greater than 4 feet, 40% between 2 and 4 feet, and 40% had transparencies less than 2 feet. Two lakes were classified as mesotrophic, and the rest, eutrophic, based on average Secchi disk transparency. (See also W90-05134) (Author's abstract)
W90-05133

VOLUNTEER LAKE MONITORING PROGRAM, 1987, VOLUME V: EAST-CENTRAL ILLINOIS REGION.
Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
J. Hawes, N. Weatherby-Thomas, and V. Wood.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-127708. Price codes: A06 in paper copy, A01 in microfiche. Report No. IEPA/WPC/88-016e, September 1988. 104p, 2 fig, 5 tab, 29 ref, 2 appendix.

Descriptors: *Illinois, *Lakes, *Water quality, *Public participation, Monitoring, Secchi disks, Field tests, Transparency, Trophic level, Water depth.

This report is Volume V of a series of 7 reports summarizing Illinois EPA's 1987 Volunteer Lake Monitoring Program (VLMP). It provides a program overview, a summary of 1987 VLMP lakes in East-Central Illinois, including a discussion of lake characteristics, volunteer participation, and a ranking of lakes on a regional basis. East-Central Illinois results are compared to statewide statistics. Lake assessment information from the Illinois Water Quality Report 1986-1987 for East-Central VLMP lakes is provided and briefly discussed. Lake/watershed management strategies are described. Sixty-six volunteers recorded total depth, Secchi disk transparency, and field observations for 28 lakes in East-Central Illinois between May and October, 1987. Average transparencies ranged from 12-97 inches. Twenty-one percent of the lakes exhibited average transparencies greater than 4 feet, 40% between 2 and 4 feet, and 39% less than 2 feet. One lake was classified as mesotrophic, and the remainder, eutrophic, based on average Secchi disk transparency. (See also W90-05133) (Author's abstract)
W90-05134

DEVELOPING AND MANAGING A COMPREHENSIVE RESERVOIR ANALYSIS MODEL.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 6A.
W90-05182

WATER QUALITY OF LAKE AUSTIN AND TOWN LAKE, AUSTIN, TEXAS.

Geological Survey, Austin, TX. Water Resources Div.

For primary bibliographic entry see Field 7C.
W90-05212

SEDIMENTATION OF LAKE TANAYCOMO, MISSOURI, 1913-1987.

Geological Survey, Rolla, MO. Water Resources Div.

For primary bibliographic entry see Field 2J.
W90-05284

STATUS AND IMPLICATIONS OF THE INVASION OF TAMARISK (TAMARIX APHYLLA) ON THE FINKE RIVER, NORTHERN TERRITORY, AUSTRALIA.

Commonwealth Scientific and Industrial Research Organization, Alice Springs (Australia). Div. of Wildlife and Rangelands Research.

G. F. Griffin, D. M. S. Smith, S. R. Morton, G. E. Allan, and K. A. Masters.

Journal of Environmental Management

JEVMAW, Vol. 29, No. 4, p. 297-315, December 1989. 4 fig, 5 tab, 25 ref.

Descriptors: *Australia, *Riparian vegetation, *Tamarisk, *Vegetation establishment, Vegetation effects, Salinity, Birds, Reptiles, Habitats, Eucalypt.

Exotic tamarisk trees have become established along several hundred kilometers of the Finke River, the largest river system in arid central Australia. The sources of infestation were plantings at homesteads near the River, and establishment appears to have taken place after heavy flooding dispersed seeds downstream and tore out the native eucalypt trees which usually dominate. In addition, flushes of saline water which have entered the Finke River from adjacent paleodrainage systems probably favored the tamarisks at the expense of the less tolerant eucalypts. Displacement of eucalypts by tamarisks has resulted in dominance of the ground vegetation by a relatively few species of introduced or salt-tolerant plants, and in reduction in the numbers of native birds and reptiles. Tamarisks are reducing the pastoral and conservation value of the Finke River by impoverishing the native biota. The conditions allowing their establishment are uncommon but recurrent, and unless positive steps are taken to inhibit their spread they will probably invade other river systems in inland Australia. (Author's abstract)
W90-05294

YOUNG FISH DISTRIBUTION IN BACKWATERS AND MAIN-CHANNEL BORDERS OF THE KANAWHA RIVER, WEST VIRGINIA.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.

M. T. Scott, and L. A. Nielsen.

Journal of Fish Biology JFIBA9, Vol. 35, No. SA, p. 21-27, December 1989. 2 tab, 29 ref.

Descriptors: *West Virginia, *Fish populations, *Stream fisheries, *Fish, Spawning, Fish distribution, Species diversity, Shiner, Dorosoma, Bluegills, Habitats.

Fish in the Kanawha River were collected with a 0.5 m plankton net in main-channel borders and in open areas of backwaters and with a 1 sq m enclosed dropbox in shallow backwater habitats. Larval emerald shiners, *Notropis atherinoides*, were twice as dense, and gizzard shad, *Dorosoma cepedianum*, 2.5 times as dense in main-channel borders as in backwaters; larval *Lepomis* spp. were 20 times as dense in backwaters as in main-channel borders. Smaller *Lepomis* larvae used open-water backwater areas primarily; larger larvae migrated to vegetated backwater habitats later in the summer. Backwaters appear crucial for the maintenance of nest-building fish species in temperate rivers, just as floodplains are necessary for the maintenance of high species diversity in tropical rivers. (Author's abstract)
W90-05296

HEAT DEATH OF FISH IN SHRINKING STREAM POOLS.

Miami Univ. Middletown, OH. Dept. of Zoology.

For primary bibliographic entry see Field 8I.

W90-05310

DIEL AND SEASONAL DRIFT OF ZOOPLANKTON IN A HEADWATER STREAM.

Arkansas Univ., Fayetteville. Dept. of Zoology. M. D. Schram, A. V. Brown, and D. C. Jackson. American Midland Naturalist AMNAAF, Vol. 123, No. 1, p. 135-143, January 1990. 2 fig, 1 tab, 37 ref. NSF Grant ISP 8011447 and BSR 8516857, and Arkansas Science and Technology Authority Grant 86-B-0112.

Descriptors: *Zooplankton, *Stream biota, *Seston, *Macroinvertebrates, *Diurnal distribution, Seasonal variation, Arkansas, Rivers, Population density, Aquatic populations, Copepods, Waterfleas, Rotifers, Fish food organisms.

Diel periodicity of Zooplankton drift was examined in a third order reach of the Illinois River, Arkansas. Quantitative samples were taken every 2 hours for a 24-hour period during June 1987 and January 1988, to determine if zooplankton drifted in greater numbers at night. Significantly more zooplankton ($p < 0.05$, Wilcoxon) were collected at night during both sampling periods. Day-night densities also were significant for total Copepoda and nauplii in June and January, *Euchlanis dilatata* in June, and *Rotatoria* and immature *Cladocera* (*Bosmina* and *Daphnia*) in January. Apparent, but nonsignificant differences were observed for *Cladocera* in June and January, and *Rotatoria* in June. Maximum densities during June were recorded from 2000 to 2200 hours for all major groups. Maximum rotifer density was strongly influenced by distinct peaks of *bdelloids* and *E. dilatata* at 2000 and 2200 hours, respectively. January samples were more variable, but maximum densities for Copepoda and total zooplankton were recorded from 2100 to 0100 hours, and *Rotatoria* from 2300 to 0100 hours. *Cladocera* maximum densities occurred at 1900 and 0300 hours, coinciding with distinct peaks for *Bosmina longirostris*. Drift of *Keratella cochlearis*, an abundant rotifer, peaked at 2300 hour. Greater densities (ca. 7x) of drifting zooplankton were recorded in January than in June. Diel pulses of drifting zooplankton at night increased the animal component of the seston. Zooplankton may significantly influence the trophic dynamics and activity patterns of filter-feeding macroinvertebrates and planktivorous fish in headwater stream communities. (Author's abstract)
W90-05311

LIFE HISTORY OF ANADROMOUS COASTAL CUTTHROAT TROUT IN SNOW AND SALMON CREEKS, JEFFERSON COUNTY, WASHINGTON, WITH IMPLICATIONS FOR MANAGEMENT.

Snow Creek Research Station, Port Townsend, WA.

For primary bibliographic entry see Field 8I.

W90-05322

OXYGEN AND TEMPERATURE RELATIONSHIPS IN NINE ARTIFICIALLY AERATED CALIFORNIA RESERVOIRS.

Hawaii Inst. of Marine Biology, Honolulu.

For primary bibliographic entry see Field 5G.
W90-05323

TEMPORAL AND SPATIAL VARIATION IN PELAGIC FISH ABUNDANCE IN LAKE MEAD DETERMINED FROM ECHOGRAMS.

Nevada Univ., Las Vegas. Lake Mead Limnological Research Center.

For primary bibliographic entry see Field 8I.

W90-05324

STABLE ISOTOPE COMPOSITION OF LAND SNAIL BODY WATER AND ITS RELATION TO ENVIRONMENTAL WATERS AND SHELL CARBONATE.

Weizmann Inst. of Science, Rehovoth (Israel).

Dept. of Isotope Research.

G. A. Goodfriend, M. Magaritz, and J. R. Gat.

Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 12, p. 3215-3221, December 1989. 8 fig, 32 ref.

Descriptors: *Water exchange, *Deuterium, *Oxygen isotopes, *Snails, *Metabolism, *Carbonates, Bioassay, Environmental effects, Temporal distribution, Rain, Shells, Water vapor, Equilibrium, Israel.

Day-to day and within-day (diel) variations in delta D (deuterium) and delta O18 of the body water of the land snail, *Theba pisana*, were studied at a site in the southern coastal plain of Israel. Three phases of variation, which relate to isotopic changes in atmospheric water vapor, were distinguished: 1) on rainy days, snail water becomes isotopically depleted approximately in the direction of the rain isotope values, but always less depleted in D as is atmospheric water vapor; 2) during the 1 to 3 days following a rain, the snail water becomes isotopically enriched along a line with slope < 8 , in delta D versus delta O18 space (this relates to a increasing influenced of humidity derived from the Mediterranean Sea); and 3) a period of relative stability of the isotopic composition persists until the next rain event. The isotopic variations can be explained by isotopic equilibration with atmospheric water vapor and/or uptake of dew derived from it. During the winter, when the snails are active, there is only very minor enrichment in O18 relative to equilibrium with water vapor or dew, apparently as a result of metabolic activity. But this enrichment becomes pronounced after long periods of inactivity. Within-day variation in body water isotopic composition is minor on non-rain days. Shell carbonate is enriched in O18 by approximately 1 to 2 ppt relative to equilibrium with body water. In most regions, the isotopic composition of atmospheric water vapor (or dew) is a direct function of that of rain. Because the isotopic composition of snail body water is related to that of atmospheric water vapor and the isotopic composition of shell carbonate in turn is related to that of body water, land snail shell carbonate O18 should provide a reliable indication of rainfall O18. However, local environmental conditions and the ecological properties of the snail species must be taken into account. (Author's abstract)
W90-05325

RESIDUES OF FLURIDONE AND A POTENTIAL PHOTOPRODUCT (N-METHYLFORMAMIDE) IN WATER AND HYDROSOIL TREATED WITH THE AQUATIC HERBICIDE SONAR.

Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab.

For primary bibliographic entry see Field 5B.

W90-05326

LEAD IN THE BOTTOM SEDIMENTS OF LAKE NUANGOLA AND FOURTEEN OTHER BODIES OF WATER IN LUZERNE COUNTY, PENNSYLVANIA.

Wilkes Coll., Wilkes-Barre, PA. Dept. of Earth and Environmental Sciences.

For primary bibliographic entry see Field 5B.

W90-05335

SEASONAL RHYTHMS AND COMPONENTS BY STATION IN THE AQUATIC ENVIRONMENT: II. TAKING INTO ACCOUNT AND ELIMINATING THEIR EFFECTS FROM A FAUNISTIC CATALOG (RHYTHMES SAISONNIERS ET COMPOSANTES STATIONNELLES EN MILIEU AQUATIQUE: II. PRISE EN COMPTE ET ELIMINATION D'EFFETS DANS UN TABLEAU FAUNISTIQUE).

Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.

S. Doledet, and D. Chessel.

Acta Oecologia, Oecologia Generalis AOSGD7, Vol. 10, No. 3, p. 207-232, 1989. 8 fig, 1 tab, 102 ref. English summary.

Field 2—WATER CYCLE

Group 2H—Lakes

Descriptors: *Stream biota, *Benthic fauna, *Temporal distribution, *Spatial distribution, Lotic environment, Seasonal variation, Time series analysis, Data interpretation.

The study of the distribution of aquatic macroinvertebrate communities, as well as the study of vegetation dynamics by permanent quadrats, involves the description of tri-dimensional data matrices. Five analytical strategies, respectively called separate, mixed, conditional, between-group, and connected analysis are possible. This paper demonstrates how within-class and between class correspondence analysis is central to all these methodological options. This method is described from a practical point of view and the main properties are illustrated using the benthic macroinvertebrate fauna sampled seven times during 1982-1983 in six stations, on the Lower Ardeche River. In this unstable Mediterranean ecosystem, the seasonal typology is strong. Seasonal fluctuation in the aquatic fauna is related to thermal variations of the water and varies as the sampling proceeds downstream. The common spatial typology is influenced by habitat diversity, current velocity and the downstream succession of sampling stations. Floods homogenize the fauna between the stations. During low water, the fauna structure varies between summer and winter. (Author's abstract) W90-05337

GENUS ISOETES IN SCANDINAVIA: AN ECOLOGICAL REVIEW AND PERSPECTIVES.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W90-05338

HABITAT CONDITIONS OF THE PHYTOCOENOSSES OF MYRIOPHYLLETUM ALTERNIFLORI LEMEE 1937 EM. SISS. 1943, MYRIOPHYLLETUM VERTICILLATI SOO 1927 AND MYRIOPHYLLETUM SPICATI SOO 1927 IN POLAND.
Warsaw Univ. (Poland). Dept. of Phytogeography.
S. Kłosowski, and H. Tomaszewicz.
Aquatic Botany AQBODS, Vol. 35, No. 3-4, p 337-356, November 1989. 5 fig, tab, 48 ref.

*Aquatic plants, *Aquatic habitats, *Limnology, *Microphytes, *Substrates, *Eutrophication, *Poland, Organic matter, Calcium, Magnesium, Oligotrophic lakes, Mesotrophic lakes, Nutrients, Eutrophic lakes, Myriophyllum.

A comparative analysis was made of the habitats of *Myriophyllum alterniflorum*, *Myriophyllum verticillatum* and *Myriophyllum spicatum* phytocoenoses form 50 lakes within northern and south-eastern Poland. The phytosociological distinctness of the associations studied, based on floristic dominance, is confirmed in the distinction of their habitats, both with respect to water and substrate chemistry. *Myriophyllum alterniflorum* phytocoenoses in Poland are restricted to soft, oligotrophic-mesotrophic waters, poor in calcium and magnesium, and to substrates also poor in these elements. *Myriophyllum verticillatum* phytocoenoses occur in mesotrophic or slightly eutrophic waters, poor in N03-N, P04-P, and K on hydrated, organic and organic-mineral substrates, mostly rich in calcium. The phytocoenoses of *Myriophyllum spicatum* grow in waters with a wide trophic amplitude, although their optimum development occurs in typical eutrophic waters. They may be indicators of substrates poor in organic matter. (Author's abstract) W90-05339

NOT EVERY WEARY RIVER WINDS SOMEWHERE SAFE TO SEA—THE SEA, AND THE SALT LAKES.
Lund Univ. (Sweden). Chemistry Centre.
S. Ahrlund.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p 3-9, 1989. 1 fig, 5 tab, 8 ref.

Descriptors: *Limnology, *Saline lakes, Lake classification, Ions, Chlorides, Sulfates, Carbonates, Geology.

About half of the Earth's inland surface water is found in the saline lakes. The salinities and the ionic compositions of the waters of these lakes vary widely, in striking contrast to ocean water. Three main types, the chloride, sulfate and carbonate lakes, may be identified. In the first class, chloride is, as in the ocean, the predominant anion. In the second and third types, sulfate and carbonate, respectively, play a much more predominant role than in the ocean. These variations evidently reflect the differences in geology of the drainage areas, and age and history of the lakes. In many cases, however, much remains to be done before the genesis of a lake has been elucidated in a satisfactory way. (Author's abstract) W90-05341

MERCURY CONCENTRATIONS OF PERCH, PERCA FLUVIATILIS L., IN SMALL FINNISH HEADWATER LAKES WITH DIFFERENT PH AND WATER COLOUR.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5B.
W90-05342

WINTER AND SPRING VARIABILITY IN PHYTO- AND BACTERIOPLANKTON IN LAKES WITH DIFFERENT WATER COLOUR.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
L. Arvola, and P. Kankaala.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p 29-39, 1989. 6 fig, 2 tab, 51 ref. University of Helsinki, Academy of Finland.

Descriptors: *Lakes, *Humic acids, *Color, *Limnology, *Phytoplankton, *Plankton, *Aquatic bacteria, *Aquatic productivity, *Biomass, *Dissolved solids, Opacity, Seasonal variation, Decomposing organic matter, Acidic water.

During one winter and spring period, a survey was made of the phyto-plankton and bacterioplankton populations in five small, acid (pH 4.5-5.5), forest lakes with water color ranging between 15-370 mg Pt/L. During mid-winter, algae were sparse and their biomasses low, with the exception of one mesohumic lake in which a dense, autotrophic, picoplankton population occurred. In two clear-water lakes, autotrophic algae achieved dominance (> 75% of the total algal biomass) by March, when the ice and snow cover was thickest. In humic lakes, autotrophic algae only became dominant after the break of ice. In all lakes, the spring algal bloom in April and May was dominated by chlorophytes (mainly *Chlamydomonas* spp.). At the same time, the density of bacteria was maximal in all lakes, indicating a strong interaction between algae and bacteria. The higher ratio between bacterial and algal biomasses observed in humic lakes compared to clear lakes supports the hypothesis that dissolved allochthonous organic matter promotes the growth of bacteria. (Author's abstract) W90-05343

WATER QUALITY DEVELOPMENT OF THE ARTIFICIAL LAKES LOKKA AND PORTTIPALTA IN FINNISH LAPLAND.
Water and Environment District of Lapland, Rovaniemi (Finland).
For primary bibliographic entry see Field 5G.
W90-05344

PLANKTON COMMUNITY RESPONSE TO REDUCTION OF PLANKTIVOROUS FISH POPULATIONS: A REVIEW OF 11 CASE STUDIES.
Oslo Univ. (Norway). Biologisk Inst.
For primary bibliographic entry see Field 6G.
W90-05345

NUTRIENT CYCLING IN THE EPILITHON OF RUNNING WATERS.
Waterloo Univ. (Ontario). Dept. of Biology.
B.J. Paul, and H.C. Duthie.
Canadian Journal of Botany CJBOAW, Vol. 67, No. 8, p 2302-2309, August 1989. 5 fig, 5 tab, 52

ref. Natural Sciences and Engineering Research Council of Canada.

Descriptors: *Stream biota, *Cycling nutrients, *Limiting nutrients, Running waters, Phosphorus, Organic compounds, Limiting nutrients, Microorganisms, Hydrobiology.

The development and physiology of microcommunities established on glass slides was investigated in the Matamek River, Quebec, during the summer of 1985. Microorganisms loosely attached to the substrate (overstory) and those strongly adhering to the substrate (understory) were considered separately. Community biomass accumulation resulted from increases in the overstory. Cell numbers remained relatively unchanged in the understory. As the community developed, the uptake of glucose, inorganic carbon, ammonia, and phosphate increased, mainly because of autotrophic organisms in the overstory. Organisms in the understory, especially bacteria, appeared to contribute significantly to the assimilation of glucose. The spiralling concept of nutrient reutilization in running waters was assessed in view of the changing physiology of the microorganisms comprising a developing biofilm. Release, downstream location, and subsequent biological assimilation of recently fixed bicarbonate, glucose, and orthophosphate was measured. The translocation of bicarbonate and glucose release products was similar in both poorly developed and well-developed communities, whereas orthophosphate metabolites were reassembled more rapidly in well-developed assemblages. The apparent conservation of phosphate by the epilithic community was considered to be a physiological adaptation in response to the low nutrient concentration of the waters. Organic carbon, conversely, was probably not limiting and therefore was not rapidly reutilized. It is concluded that the intensity at which compounds are utilized is directly proportional to their degree of limitation in the epilithic community. (Author's abstract) W90-05352

SUBMERSED MACROPHYTES ACCUMULATES BEFORE AND AFTER AN EPISODIC ICE JAM IN THE ST. CLAIR AND DETROIT RIVERS.
National Fisheries Research Center-Great Lakes, Ann Arbor, MI.
For primary bibliographic entry see Field 2C.
W90-05353

FREQUENCY AND LOCAL ABUNDANCE OF RUPPIA OCCIDENTALIS IN RELATION TO SEDIMENT TEXTURE AND LAKE SALINITY.
Toronto Univ. (Ontario). Dept. of Botany.
B.C. Husband, and M. Hickman.
Canadian Journal of Botany (CJBOAW), Vol. 67, No. 8, p 2444-2449, August 1989. 2 fig, 3 tab, 46 ref. Natural Sciences and Engineering Research Council of Canada.

Descriptors: *Limnology, *Macrophytes, *Ecological distribution, *Sediments, *Salinity, Saline lakes.

To determine the effect of water salinity on the distribution of *Ruppia occidentalis*, the frequency and local abundance of this macrophyte in relation to sediment texture was investigated in three lakes in Alberta, Canada, having 2165, 1557, and 275 mg/L total dissolved solids (TDS), respectively. Sediment texture was found to have the largest effect on local abundance in freshwater, and differences between lakes were greatest on the sediment with the greatest local abundance. *Ruppia occidentalis* occurred at 82, 79, and 42%, respectively, of the sites examined within these lakes. This reduction in frequency was associated with a decrease in the diversity of sediment textures in which *R. occidentalis* occurred. Within the saline lakes, the frequency of *R. occidentalis* was not dependent on sediment texture. In freshwater, however, *R. occidentalis* is found primarily on coarse-textured sediments in freshwater environments is not correlated with the abundance of other macrophytes. Local environments associated with coarse sedi-

ments, such as low organic content, or reduced biotic interactions, are necessary for *R. occidentalis* to occur in freshwater. However, contrary to the patterns of frequency among sites, local abundance was not significantly correlated with lake salinity, except on sandy sites. Therefore, the effects of water salinity on colonization of new sites, rather than the performance within sites, may be most important in determining distributional limits of *R. occidentalis* in central Alberta. (Author's abstract)
W90-05354

BOTTOM-UP AND TOP-DOWN IMPACTS ON FRESHWATER PELAGIC COMMUNITY STRUCTURE.

York Univ., Toronto (Ontario). Dept. of Biology. D. J. McQueen, M. R. S. Johannes, J. R. Post, T. J. Stewart, and D. R. S. Lean.
Ecological Monographs ECOMAQ, Vol. 59, No. 3, p. 289-309, September 1989. 15 fig. 1 tab, 82 ref., 4 append. National Sciences and Engineering Research Council of Canada.

Descriptors: *Limnology, *Food chains, *Species composition, *Zooplankton, *Phytoplankton, *Biomass, Distribution patterns, Aquatic productivity, Predation, Chlorophyll a, Phosphorus, Daphnia.

To test the predictions of biomanipulation, cascading trophic interaction, and bottom-up/top-down theories for freshwater pelagic community structure, researchers measured: piscivore and planktivore numbers; zooplankton species composition, size structure, and biomass; chlorophyll A concentration and Secchi depth; and water chemistry from 1980 through 1986 in Lake St. George, Ontario, Canada. Prior to the winterkill of 1981-1982, the piscivore population was high (1000-2000 piscivores/ha), the planktivore population was intermediate (8000-10 000 planktivores/ha), zooplankton biomass was intermediate (2400 micrograms/L), and chlorophyll A concentration was high (5-12 microgram/L). In the year following the winterkill (1982), piscivore and planktivore numbers were low, and zooplankton biomass and chlorophyll A concentrations were high. During the next two years (1983-1984), the planktivore population increased rapidly to densities >20 000 individuals/ha, zooplankton biomass density decreased to <1600 micrograms/L and chlorophyll A concentration decreased. During the final two years of the study, piscivores recruited to near prewinterkill levels, planktivores were reduced to <8000 individuals/ha, zooplankton biomass increased, and chlorophyll A concentration decreased. Over the 7 year data set, a strong negative correlation between numbers of piscivores and planktivores, a weaker correlation between numbers of planktivores and zooplankton biomass, and no between year correlation between zooplankton biomass and chlorophyll A concentration was found. There was, however, a positive correlation between total epilimnetic phosphorus and chlorophyll A concentration. These data are consistent with predictions made by the bottom-up/top-down model, and the implication is that at Lake St. George, the trophic cascade uncouples at the zooplankton-phytoplankton link. It is speculated that this may be due to the combine effects of lake trophy and *Daphnia* species composition and size. (Author's abstract)
W90-05355

SEASONAL DYNAMICS OF THE CHESAPEAKE BAY ECOSYSTEM.

Maryland Univ., Solomons. Chesapeake Biological Lab.
For primary bibliographic entry see Field 2L.
W90-05356

HYDROLOGY, COMMUNITY STRUCTURE, AND PRODUCTIVITY PATTERNS OF A DYSTROPHIC CAROLINA BAY WETLAND.

Emory Univ., Atlanta, GA. Dept. of Biology. J. F. Schalles, and D. J. Shure.
Ecological Monographs ECOMAQ, Vol. 59, No. 4, p. 365-385, December 1989. 15 fig. 5 tab, 93 ref. Department of Energy Grant AT-40-1-2412.

Descriptors: *Bays, *Wetlands, *Carolina bays, *Limnology, *Geohydrology, *Surface-groundwater relations, *Biomass, *Photosynthetic bacteria, Primary productivity, Secondary productivity, Ecosystems, Distribution patterns.

To test the premise that biomass and production are constrained by stagnant hydrology and dilute, acidic chemistry of bay wetlands, surface and subsurface hydrology, sources of production, community change along a depth gradient, and seasonal community patterns were evaluated in a shallow, 5.4-ha dystrophic Carolina bay wetland. Surface hydrology was dependent on seasonal and annual precipitation patterns. Lateral, episodic ground-water exchanges accounted for the dilute surface chemistry and apparent differences in surface gains and losses. Substrate exposure and fire oxidation in dry years promoted low detritus standing crops and a dark, clay loam mineral soil. A depth gradient produced strong spatial patterns for most community components. Aquatic macrophytes had low shoot biomass and a high root to shoot ratio. Algae were light limited and even less productive. Purple photosynthetic bacteria approached algal productivity levels and may have important chemistry and trophic support functions. As predicted from the stagnant, dystrophic conditions, autotroph biomass and production were low. However, the warm climate and periodic fire rejuvenation may stimulate higher production than that generally found in northern bog wetlands. Secondary production was also low. Animal biomass was dominated by insects (especially odonates) and salamanders. High turnover of prey (largely midge larvae and microcrustaceans) was implied by the predator dominated community structure. This study of a wetland ecosystem lacking several common dystrophic bog features (peat deposit, high dissolved organic matter, acidophilic mosses) expands current knowledge of the dystrophic condition. (Author's abstract)
W90-05357

TOWARDS A BIOLOGICAL AND CHEMICAL DEFINITION OF THE HYPOHEIC ZONE IN TWO CANADIAN RIVERS.

Toronto Univ. (Ontario). Div. of Life Sciences. For primary bibliographic entry see Field 2F.
W90-05358

PERIPHYTON BIOMASS DYNAMICS IN GRAVEL BED RIVERS: THE RELATIVE EFFECTS OF FLOWS AND NUTRIENTS.

Department of Scientific and Industrial Research, Christchurch (New Zealand). Hydrology Centre. B. J. F. Biggs, and M. E. Close.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p. 209-231, October 1989. 11 fig. 10 tab, 48 ref.

Descriptors: *Algae, *Periphyton, *Alluvial channels, *River flow, *Biomass, *Nutrients, *Flow pattern, Chlorophyll a, Scouring, Correlation analysis, Gravel bed rivers.

Periphyton chlorophyll-a and ash free dry weight (AFDW) were monitored in nine rivers to examine the relative importance of flows and nutrients for regulating periphyton biomass in gravel bed rivers. Mean annual flows ranged from 0.9 to 169 cum/s, mean dissolved reactive phosphorus (DRP) from 1.3 to 68 micrograms/L, periphytic chlorophyll-a from 4.6 to 73 mg/sq m, and AFDW from 2.8 to 16 g/sq m. For eight of the nine rivers NH₄-N, DRP, total Kjeldahl nitrogen, total phosphorus and total suspended solids were correlated ($P < 0.01$) with flow, and for seven rivers conductivity was inversely correlated ($P < 0.05$) with flow. There was a hyperbolic relationship between flows and biomass, with chlorophyll-a > 100 mg/sq m and AFDW > 20 g/sq m occurring most frequently in flows of < 20 cum/s. Floods prevented the development of medium term (i.e. up to 2 months) maxima in biomass in five of the rivers, but maxima occurred over summer-autumn and winter-spring in the three rivers where floods were absent. Chlorophyll-a biomass was more resistant to flooding than AFDW. Only 59% of the forty-six recorded floods caused chlorophyll-a scouring, whereas 74% of the floods caused AFDW scouring. The efficiency of scour was influenced more

by pre-flood biomass than the magnitude of the event. Biomass maxima were significantly correlated ($P < 0.01$) with mean DRP concentration during the accrual period. Overall, up to 53% of the mean annual biomass difference between rivers was explained by the mean DRP concentrations. However, the high correlations between nutrient concentrations and flow indicated that the nutrient data were also carrying hydrological information and that simple causal relationships between nutrients and biomass are difficult to establish in rivers. It is concluded that hydrological factors contribute at least equally with nutrients to the differences in periphyton biomass between the gravel-bed study rivers. They combined to explain up to 63.3% of the variance in biomass, compared with 57.6% for nutrients. It is recommended that periphyton data from gravel-bed rivers should always be viewed within the context of the flow history of the site, and not just as a function of nutrient concentrations. (Author's abstract)
W90-05359

MICROHABITAT AVAILABILITY IN WELSH MOORLAND AND FOREST STREAMS AS A DETERMINANT OF MACROINVERTEBRATE DISTRIBUTION.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.
G. P. Rutt, N. S. Weatherley, and S. J. Ormerod.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p. 247-261, October 1989. 6 fig. 5 tab, 54 ref.

Descriptors: *Acid rain effects, *Macrophytes, *Wales, *Stream biota, *Aquatic habitats, *Macroinvertebrates, *Acid streams, Hydrogen ion concentration, Bioindicators.

Eighteen streams in mid-Wales were sampled for macroinvertebrates in both riffles and margins from April 1985 to April 1987. Stream macroflora, substrata and marginal habitats were surveyed in May 1988. TWINSPLAN classification of the macroinvertebrate data indicated three major stream groups. One was distinguished by circumneutral pH and had flora and fauna typical of such conditions. The two other groups consisted of acidic streams with moorland and reforested conifer catchments respectively. The forest streams were the most acidic but the two groups also differed significantly in the composition of their marginal habitats. The acidic moorland streams had more vegetation ('soft' features) in the margins and supported several invertebrate taxa which were relatively more abundant there than in the riffles. These taxa may be excluded from forest streams because the margins are 'hard' due to greater erosiveness and shading. In view of the increasing cover by conifer reforestation in Britain, it is clearly necessary to elucidate all its effects on stream ecosystems, which include changes to the physical environment. (Author's abstract)
W90-05360

VERTICAL DISTRIBUTION AND ABUNDANCE OF INVERTEBRATES WITHIN THE SANDY SUBSTRATE OF A LOW-GRADIENT HEADWATER STREAM.

J. L. Strommer, and L. A. Smock.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p. 263-274, October 1989. 5 fig. 2 tab, 32 ref. National Science Foundation (BSR-8315763) (BSR-8614828).

Descriptors: *Invertebrates, *Aquatic animals, *Stream biota, *Headwaters, *Species composition, Streams, Vertical distribution, Midge, Nematodes, Crustaceans, Caddisflies, Population density, Biomass.

The vertical distribution of invertebrates (>0.053 mm) was studied in a sandy-bottomed, first-order stream, on the Coastal Plain of Virginia. Invertebrate species composition, abundance and biomass were determined monthly over one year at sediment depth intervals of 0-1, 1-5, 15-30, and 30-40 cm. The subsurface community was numerically dominated by species of Chironomidae, Nematoda and Crustacea, while much of the biomass was due to early instars of several species of Trichoptera.

Field 2—WATER CYCLE

Group 2H—Lakes

Invertebrate density and biomass decreased significantly with depth in the substrate (ANOVA; $P < 0.05$). Annual mean density decreased from 1,346,844 individuals/cu m at the surface to 13,578 individuals/cu m at 15–30 cm. Annual mean biomass decreased from 66.30g/cu m at the surface to 0.44 g/cu m at 15–30 cm. Dissolved oxygen decreased markedly from the surface to the 5 cm depth in the substrate, anaerobic conditions often occurring below 10 cm. Density and biomass both showed a significant positive relationship with dissolved oxygen concentration (Linear regression; $P < 0.05$). Physical forces were important in structuring the subsurface invertebrate community. Besides low dissolved oxygen concentration, sediment scouring resulting from storm discharge dramatically reduced density and biomass. (Author's abstract) 26805010
W90-05361

DISSOLUTION OF CALCITE IN ACID WATERS: MASS TRANSPORT VERSUS SURFACE CONTROL.
Oxford Univ. (England). Physical Chemistry Lab. For primary bibliographic entry see Field 5G.
W90-05362

HYDROLYTIC EXTRACELLULAR ENZYME ACTIVITY IN HETEROTROPHIC BIOFILMS FROM TWO CONTRASTING STREAMS.
University Coll. of North Wales, Bangor. School of Biological Sciences.
S. E. Jones, and M. A. Lock.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p 289–296, October 1989. 5 fig, 1 tab, 32 ref.

Descriptors: *Enzymes, *Aquatic bacteria, *Stream biota, Population density, Esterase, Oligotrophic, Eutrophic, Extracellular enzymes, Metabolic activity, Wales.

Extracellular hydrolytic enzyme activities and cell densities were monitored during undisturbed biofilm formation on pristine surfaces in two contrasting river sites in North Wales: an oligotrophic mountain stream (Nant Waen) and a mildly eutrophic river (River Clywedog). Bacterial densities generally increased at both sites over a 33-day monitoring period. Densities in the eutrophic site were approximately 14 times greater than in the mountain stream. Using fluorescent substrate analogues, biofilms from Nant Waen produced low, variable xylosidase and beta-glucosidase activities and detectable endopeptidase, though these activities also fluctuated during the colonization period. Unlike the other activities measured, esterase activities in the River Clywedog were correlated with cell densities ($P < 0.05$). When extracellular esterase activities per cell were calculated, the oligotrophic biofilm was found to contain about twice as much extracellular esterase activity as the more eutrophic River Clywedog biofilm. (Author's abstract)
W90-05363

DISTRIBUTION OF MACROINVERTEBRATE COMMUNITIES IN TWO PORTUGUESE RIVERS.

Coimbra Univ. (Portugal). Dept. de Zoologia.
M. A. S. Graca, D. M. Fomesca, and S. T. Castro.
Freshwater Biology FWBLAB, Vol. 22, No. 2, p 297–308, October 1989. 4 fig, 1 tab, 29 ref, append.

Descriptors: *Stream biota, *Portugal, *Acid streams, *Macroinvertebrates, *Alkaline water, Seasonal variation, Alkalinity, Conductivity, Hydrogen ion concentration, Distribution, Temporal distribution.

The distribution of macroinvertebrates in two chemically different rivers in of Central Portugal (Soure and Alva) was analyzed. In the Soure, a lowland, alkaline river (mean values for alkalinity, conductivity and pH, 110 mg/L CaCO₃, 255 microsiemens (s)/cm and 7.8, respectively), a relatively high number of individuals and low diversity (mean $H' = 2.27$) was found. There was considerable temporal variation in the number of individuals present. In the Alva, a highland, acidic river (mean values for alkalinity, conductivity and pH,

4.8 mg/L CaCO₃, 22 microS/cm and 5.7, respectively) diversity was higher (mean $H' = 3.41$). There were large temporal changes in the number of species present, but not in the number of individuals. Similarity indices and cluster analysis identified six site-types and seventeen groups of co-occurring taxa. Some of the taxonomic groups were characteristic of one or more sites, but others had no strong association with a particular site. Although the rivers differed considerably in terms of physical chemistry, communities in the upper sections of the two rivers were more similar to each other than to other communities in the same river. The way samples of both rivers were clustered seems to indicate that community structure was influenced by factors associated with river longitudinal variation (e.g. substrate grain size), water chemistry, and seasonal variations (e.g. temperature, flow). (Author's abstract)
W90-05364

LIMNOLOGICAL RECONNAISSANCE OF WATER BODIES IN CENTRAL AND SOUTHERN NEPAL.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
J. R. Jones, M. F. Knowlton, and D. B. Swar.
Hydrobiologia HYDRB8, Vol. 184, No. 3, p 171–189, November 8, 1989. 5 fig, 5 tab, 78 ref. National Science Foundation grant no. INT-8407884, Missouri Agricultural Experiment Station project no. 184.

Descriptors: *Limnology, *Lakes, *Nutrients, *Nepal, *Eutrophic lakes, Nitrogen, Transparency, Water properties, Salinity, Ionic composition, Water chemistry, Algae.

Ionic composition of waterbodies in central and southern Nepal sampled in spring 1985 differed from that normally found in freshwater. Distinguishing characteristics were predominance of bicarbonate among the anions—accounting for > 90% of the negative equivalents in two-thirds of the waterbodies; the near absence of sulfates—accounting for < 1% of the anions in half the samples so that chloride exceeded sulfate (as meq/L) in three-fourths of the waters tested; and calcium was the dominant cation, although in certain waters the relative proportion of either magnesium or the monovalent cations was much higher than the world average. Regional patterns in water chemistry were apparent and are largely explained by differences in local geology, inputs from artesian wells or extensive use by humans. Most ionic salinity values were < 400 mg/L. Using conventional criteria to assess trophic state, most waterbodies were eutrophic or hypereutrophic when judged by total phosphorous and chlorophyll content, but as a whole the lakes sampled were low in nitrogen. Nitrogen-phosphorous ratios (generally < 10) and a significant empirical relation for chlorophyll-nitrogen provide evidence that nitrogen limited algal biomass. Secchi transparency values indicate light regimes were affected by nonalgal materials. (Author's abstract)
W90-05371

ALGAL EPILITHON AND WATER QUALITY OF A STREAM RECEIVING OIL REFINERY EFFLUENT.

North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-05372

GROWTH INHIBITION BY HIGH LIGHT INTENSITIES IN ALGAE FROM LAKES UNDERGOING ACIDIFICATION.

University of Western Ontario, London. Dept. of Plant Sciences.
For primary bibliographic entry see Field 5C.
W90-05373

GROWTH AND DEVELOPMENT OF POTAMOGETON DISTINCTUS IN AN IRRIGATION POND IN SW JAPAN.
Oldenburg Univ. (Germany, F.R.).
G. Wiegand, and Y. Kadono.

Nordic Journal of Botany NJBODK, Vol. 9, No. 3, p 241–249, 1989. 8 fig, 2 tab, 25 ref.

Descriptors: *Macrophytes, *Aquatic plants, *Irrigation canals, Biomass, Primary productivity, Life history studies, Potamogeton, Growth, Japan.

Growth and development of a population of Potamogeton distinctus were studied over one vegetation period. The morphological structure of the species is described. Maximum development of the size of shoot complexes occurred in August (up to 12 grams dry weight/shoot complex). The plant exhibits a regular growth cycle with the continuous horizontal and vertical growth that is illustrated by the development of horizontal shoots, vertical shoots and different plant parts. The lower horizontal shoots allow an extension up to 1.8 m from the point of germination. Before the rainy season in June, the first to fifth generations of vertical shoots mainly contribute to the standing crop of the plants' stand, and after the rainy season, the fifth to ninth generation shoots are predominant. Floating leaves make up the main proportion of biomass during the whole growth cycle. Almost 100% of the shoot complexes were found flowering and producing numerous seeds. Up to 16% of the standing crop are allocated to inflorescence and seeds in August. Turions failed to form that year because of rapid desiccation of the habitat. The observed average lifetime of a vertical shoot is approximately 65 days, and the estimated turnover rate (defined as the length of vegetation period divided by the average lifetime of shoots) is between 2.15 and 2.27. (Author's abstract)
W90-05380

CHEMISTRY OF HIGH MOUNTAIN LAKES IN SILICEOUS CATCHMENTS OF THE CENTRAL EASTERN ALPS.

Institut fuer Limnologie, Mondsee (Austria).
R. Psenner.
Aquatic Sciences AQSCA, Vol. 51, No. 2, p 108–128, 1989. 13 fig, 3 tab, 41 ref.

Descriptors: *Acid rain effects, *Limnology, *Alpine regions, *Acidic water, *Mountain lakes, *Alkalinity, *Water chemistry, *Aluminum, *Snowmelt, Soil chemistry, Hydrogen ion concentration, Bedrock, Geology, Paleolimnology, Acid rain, Weathering, Silica, Alps, Diatoms, Paleolimnology.

Alpine lakes in siliceous catchments of Tyrol and Carinthia (Austria) show signs of acidification. About 9% of the studied lakes have no alkalinity, more than 20% are below pH 6. About two thirds of all lakes have acid neutralizing capacities below 100 microequivalents/liter. In spite of moderate precipitation acidity, some lakes show considerable concentrations of dissolved reactive aluminum during or shortly after snowmelt. High altitude lakes of the Alps are definitely more acidic than high mountain lakes in remote areas. Large differences in water and soil chemistry of nearby situated lakes were attributed to heterogeneities of bedrock geology. Paleolimnological investigations on former pH values of five lakes, based on diatom assemblages in the sediment, showed different developments: recent and past acidification, stable conditions, and alkalization. (Author's abstract)
W90-05386

SEASONAL DYNAMICS OF A CYANOBACTERIA-DOMINATED MICROBIAL COMMUNITY IN SURFACE SEDIMENTS OF A SHALLOW, EUTROPHIC LAKE.

Uppsala Univ. (Sweden). Limnologiska Institutionen.
B. Bostrom, A. K. Pettersson, and I. Ahlgren.
Aquatic Sciences AQSCA, Vol. 51, No. 2, p 153–178, 1989. 9 fig, 7 tab, 52 ref. Swedish Natural Science Research Council Grant B-BU 3083-112.

Descriptors: *Cycling nutrients, *Limnology, *Path of pollutants, *Eutrophic lakes, *Lake sediments, *Aquatic bacteria, *Phosphorus, Biomass, Lake Vallentunasjoen, Seasonal variation, Temperature effects.

The seasonal variation of microbial biomass and activity in the surface sediments (0-10 cm) of the shallow, eutrophic Lake Vallerntunsojen was followed during one year. Overwintering *Microcystis* colonies dominated the microbial community during all seasons, constituting 60-90% of the total microbial biomass. Expressed on an areal basis, the benthic biomass was, throughout the year, larger than or similar to the planktonic biomass during the peak of the summer bloom, indicating an ability of the colonies to survive in the sediments for extended periods. Abundance of other non-photosynthetic bacteria varied in the range 30,000-155,000 million cells/gm dry weight over the year with minimum values in summer and maximum values in autumn in connection with the sedimentation of the *Microcystis* bloom. A substantial part of the non-photosynthetic bacteria, up to 40%, was associated with the mucilage of healthy *Microcystis* colonies. Bacterial production (H³-thymidine incorporation) appeared to be strongly temperature dependent and less influenced by the seasonal sedimentation pattern. The data indicate an increasing proportion of non-growing cells in autumn and winter. Biomass-bound phosphorus constituted a significant portion, (10%), of the phosphorus content in Lake Vallerntunsojen sediments. This pool has normally been overlooked in studies on phosphorus dynamics in lake sediments. Different mechanisms whereby organic phosphorus can be released from the sediments include release from aquatic bacteria, algae, fungi and yeast. (Author's abstract) W90-05387

NUTRIENT STATUS AND NUTRIENT COMPETITION OF PHYTOPLANKTON IN A SHALLOW, HYPERTROPHIC LAKE.

Max-Planck-Institut fuer Limnologie zu Ploen (Germany, F.R.).
U. Sommer.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1162-1173, November 1989. 9 fig, 3 tab, 25 ref.

Descriptors: *Limnology, *Eutrophic lakes, *Phytoplankton, *Nutrients, *Diatoms, *Lakes, *Algae, Bioassay, Model studies, Limiting nutrients, Silica, Nitrogen, Organic carbon, Cyanophyta, Kinetics, Temporal distribution.

The nutritional status of phytoplankton in a shallow, hypertrophic lake was analyzed by stoichiometry of seston and by enrichment bioassays during a 6-month period. Both methods suggested moderate and temporally interrupted nutrient limitation of reproductive rates. Nitrogen was the most frequently limiting nutrient, phosphorus was next, and silicate limitation of three diatom species occurred only once. The nutritional status of the most abundant individual species could be described by the Monod equation. The nutritional status of the entire phytoplankton assemblage could be described by a modified version of the Droop equation. In accordance with competition theory, phytoplankton species were arrayed along resource ratio gradients. These results are consistent with ecophysiological models derived from culture experiments. (Author's abstract) W90-05388

METALIMNETIC CYANOBACTERIA IN HARD-WATER LAKES: BUOYANCY REGULATION AND PHYSIOLOGICAL STATE.

Purdue Univ., Lafayette, IN. Dept. of Biological Sciences.
A. Konopka.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1174-1184, November 1989. 7 fig, 6 tab, 42 ref. NSF Grant DEB 82-018957.

Descriptors: *Lakes, *Thermal stratification, *Phosphates, *Aquatic bacteria, *Limnology, *Light penetration, *Irradiation, Nitrogen, Nitrates, Ammonia, Chlorophyll a, Limiting nutrients, Phytoplankton.

During summer stratification, Crooked and Little Crooked Lakes, Indiana, contained phytoplankton dominated by populations of *Aphanizomenon* filaments that stratified in the metalimnion where

photon irradiance was 6% of that at the surface. The gas vacuolate *Aphanizomenon* filaments from Little Crooked Lake lost buoyancy when exposed to irradiances > 100 micromole photons/sq m/sec. If 2 micromole KH₂PO₄ was added to the water samples, however, exposure to irradiances > 200 micromole photons/sq m/sec was necessary to obtain buoyancy losses. Phosphate also affected the recovery of buoyancy by sinking filaments. Filaments that had lost buoyancy due to incubation in the light recovered it when incubated for 5 hr in the dark. Addition of phosphate increased the rate of buoyancy recovery by 50%. The metalimnetic populations had stratified in a zone of relatively low irradiance and inorganic nutrient concentration. The physiological state of the populations was evaluated by determining the kinetic characteristics for phosphate, nitrate, and ammonia uptake and the cellular contents of surplus phosphate and chlorophyll a. On the basis of the premise that cells limited by a particular element will express a high uptake potential for that element, the metalimnetic populations showed characteristics of organisms not limited by the availability of light, phosphorus, or nitrogen. (Author's abstract) W90-05389

INTERNAL SOURCES AND SINKS OF WATER, P, N, CA, AND CL IN LAKE KINNERET, ISRAEL.

Hawaii Inst. of Marine Biology, Honolulu.
S. V. Smith, S. Serruya, Y. Geifman, and T. Berman.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1202-1213, November 1989. 13 fig, 3 tab, 24 ref.

Descriptors: *Cycling nutrients, *Lake Kinneret, *Denitrification, *Limnology, *Hydrologic budget, *Sinks, Phosphorus, Nitrogen, Calcium, Chlorine, Israel, Hydrologic budget, Sinks, Thermal stratification, Nitrates, Sedimentation, Lake sediments, Spring water, Jordan River.

Mass-balance budgets linked among several materials were used to infer rates of processes affecting Lake Kinneret, Israel. Comparisons among budgets reveal the magnitudes of internal sources and sinks that cannot be directly inferred from individual budgets. A water budget indicates that approximately 180 million cu m of sublacustrine spring water plus unaged surface flow enters the lake annually—about a fifth of the total inflow and two-thirds as much water as is lost to evaporation. This total unaged inflow delivers about 90,000 tons of Cl/yr, nine times the stream input. Ca input from total unaged flow is about a third the stream input, and the net internal Ca sink in the system is sufficient to precipitate 60,000 tons of CaCO₃/yr. Stream delivery of P, mainly as particulate material, is largely sequestered in the sediments (approximately 100 tons/yr). At least 1,100 tons/yr of N, primarily as NO₃ delivered by streams, are apparently lost to denitrification, while only 200 tons/yr are sedimented. Cycling of N and P within the lake dominates over throughput in controlling standing stocks. Vertical mixing within the lake may play a dominating role in this cycling. Cycling of P in the lake can be regarded as closed—a sediment-water column turnover of materials with only minor hydrographic loss from the system. By contrast, N cycling is open, with an important net loss to the atmosphere. (Author's abstract) W90-05390

GEOCHEMICAL EVOLUTION OF HALITE STRUCTURES IN HYPERSALINE LAKES: THE DEAD SEA, ISRAEL.

Hebrew Univ., Jerusalem (Israel). Dept. of Geology.
J. Ganor, and A. Katz.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1214-1223, November 1989. 10 fig, 2 tab, 9 ref.

Descriptors: *Limnology, *Model studies, *Geochemistry, *Saline lakes, *Dead Sea, *Brines, *Mathematical models, Evaporation, Radiation, Saline water, Sodium chloride, Israel, Temperature effects, Sedimentation, Lake sediments, Limnology, Mixing.

Depressions in the floor of the southern basin of the Dead Sea contain dense (1.26-1.29 gm/cu cm) brines which formed by evaporation at the lake's surface. Absorption of solar radiation heats these brines by about 2.4 C/day, as long as the density gradient of the lake prevents overturn. As a result, bottom halite is dissolved in the warmer brines at about 0.4 g NaCl/liter/degree C. Continuous heating of the brine of these holes and cooling of the overlying liquids at night causes frequent overturns of the brine column, followed by mixing and cooling of the NaCl-rich brine. The extra load of halite is precipitated near the holes in the form of halite cones and mushroom-like structures. Whereas the initial NaCl supply to the growing halite structures comes from the floor of the lake, the later growth stage is supported by NaCl supplied from the upper (evaporating) brine layer. Crude mass and heat balances show that the proposed model may well explain the occurrence and distribution of halite islands in the Dead Sea. The model may be applicable to any shallow enough (a few meters) hypersaline lake that is saturated with respect to halite. (Author's abstract) W90-05391

SOLUBILITY OF HALITE AS A FUNCTION OF TEMPERATURE IN THE HIGHLY SALINE DEAD SEA BRINE SYSTEM.

Hebrew Univ., Jerusalem (Israel). Dept. of Geology.
I. Gavriel, A. Starinsky, and A. Bein.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1224-1234, November 1989. 5 fig, 5 tab, 35 ref.

Descriptors: *Brines, *Dead Sea, *Solubility, *Limnology, *Temperature effects, Saline waters, Ionic strength, Chemical precipitation, Evaporation, Mathematical studies, Saline lakes.

The Dead Sea brine is characterized by high ionic strength (I) (9-10 molality) and a CaCl₂ composition. The lake is currently saturated with respect to aragonite, gypsum, and halite. Harned's rule was applied to calculate the saturation index of halite in the Dead Sea brine system. This system includes brines at ionic strengths in the range of 9-16 molality, derived from evaporating Dead Sea brine. To facilitate the calculation, new interaction coefficients were determined experimentally. These were found to be a function of the ionic strength of the solution as well as of the temperature. At 25 C, the interaction coefficient between NaCl and MgCl₂ was 0.002611 to 0.00905, and between NaCl and CaCl₂, 0.001501 to 0.00650, when I = ionic strength (concentration in molality). At 35 C, the interaction coefficient between NaCl and MgCl₂ was 0.002831 to 0.01972, and between NaCl and CaCl₂, 0.002071 to 0.01851. At 50 C, the interaction coefficient between NaCl and MgCl₂ was 0.002261 to 0.01416, and between NaCl and CaCl₂, 0.001561 to 0.01315. The new parameters were used to predict the effect of temperature on halite precipitation in the lake from both the evaporating surface layer and the entire upper water body. The calculated weight of halite expected to precipitate before the onset of carnallite precipitation is on the order of 10,000 million tons. At the present rate of evaporation at least 120 yr will pass before that point is reached. (Author's abstract) W90-05392

EFFECTS OF PATCH SIZE AND SUBSTRATE ISOLATION ON COLONIZATION MODES AND RATES IN AN INTERTIDAL SEDIMENT.

Hawaii Inst. of Geophysics, Honolulu.
For primary bibliographic entry see Field 2L.

W90-05394

RAPID GROWTH RATES OF CHIRONOMIDS IN THREE HABITATS OF A SUBTROPICAL BLACKWATER RIVER AND THEIR IMPLICATIONS FOR P:B RATIOS.

Emory Univ., Atlanta, GA. Dept. of Biology.
D. L. Stites, and A. C. Benke.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1278-1289, November 1989. 2 fig, 5 tab, 48 ref. NSF Grants DEB 81-04427 and BSR 84-06630.

Field 2—WATER CYCLE

Group 2H—Lakes

Descriptors: *Midges, *Growth rates, *Biomass, *Rivers, *Aquatic productivity, Secondary productivity, Ogeechee River, Stream biota, Ecology, Aquatic habitats, Benthos.

Growth rates of chironomids from communities characteristic of three major stream habitats were examined at a field laboratory on the 6th-order Ogeechee River in the lower Coastal Plain of Georgia. Artificial systems that simulated environmental conditions of snags, sand, and back-water habitats were used to compare growth rates of members from these different communities. Three or more growth trials were run in each system for between 9 and 16 days. The average daily biomass growth rate for individuals across all trials was highest in the snag community (0.50/day) followed by the backwater (0.25/day) and sand (0.16/day). The low rate in sand was attributed primarily to psammophilous taxa, *Lopescladius* sp. and *Rheosmittia* sp. For taxa found in more than one habitat, no significant differences in growth among habitats were found. Taxon-specific growth rates were linearly and negatively related with the natural logarithm of mass for *Corynoneura taris* and groups of related taxa within the Tanytarsini and Polypedilum spp. Size-specific growth rates were applied to quantitative field data from summer 1982 to calculate daily productivity of selected chironomids from the sand habitat. Daily biomass turnover (productivity:biomass (P:B) = g) ranged from 0.13 to 0.51. The mean growth rate for selected sand taxa (0.31) translates into a 6-month P:B ratio (with temperatures > 20°C) of approximately 57. With the exception of the psammophilous taxa, annual P:B ratios for most taxa in all three habitats approach or exceed 100. (Author's abstract) W90-05395

GENERAL ALLOMETRIC EQUATIONS FOR RATES OF NUTRIENT UPTAKE, INGESTION, AND RESPIRATION IN PLANKTON ORGANISMS.

Cape Town Univ. (South Africa). Marine Biology Research Inst.
C. L. Moloney, and J. G. Field.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1290-1299, November 1989. 2 fig, 4 tab, 59 ref.

Descriptors: *Limnology, *Nutrients, *Respiration, *Plankton, *Mathematical studies, Aquatic bacteria, Particulate matter, Regression analysis, Metabolism, Biomass, Mathematical models.

General allometric equations were derived for rates of nutrient uptake, ingestion, and respiration by planktonic organisms. Previous studies commonly calculated parameters *a* and *b* by linear regressions on log-transformed data in the allometric equation where the rate variable (*R*) equals the rate coefficient (*a*) times the organism mass (*M*) raised to the power of the exponent (*b*). This practice results in variability between data sets in estimates of both *a* and *b*, making meaningful comparisons difficult. This problem is overcome by assuming the mass-specific form of *b* to be -0.25, based on accumulated empirical evidence. Values of *a* are then recalculated from published data, with log transformations and an assumed regression slope of -0.25. Resulting regressions predict values of *a* (in picograms C 0.25/day) at 20°C as follows: 3.6 for nutrient uptake by phytoplankton and bacteria; 63 and 13 for ingestion and respiration by particle-feeding heterotrophs. It is hypothesized that organisms that take up dissolved nutrients from solution (autotrophs and osmotrophs, e.g. phytoplankton and bacteria) have lower specific respiration rates (i.e. smaller *a*) when compared with organisms (either unicellular or multicellular) that ingest particulate material. (Author's abstract) W90-05396

SERIOUS INHIBITION PROBLEM FROM A NISKIN SAMPLER DURING PLANKTON PRODUCTIVITY STUDIES.

University Coll. of North Wales, Bangor. School of Ocean Sciences.
For primary bibliographic entry see Field 7B.
W90-05397

DEPENDENCE OF THE ASSIMILATION EFFICIENCY IN DAPHNIA MAGNA ON THE C14-LABELING PERIOD OF THE FOOD ALGA SCENEDESMUS ACUTUS.

Trondheim Univ. (Norway). Dept. of Zoology.
M. V. Nielsen, and Y. Olsen.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1311-1315, November 1989. 2 fig, 11 ref.

Descriptors: *Carbon radioisotopes, *Limnology, *Daphnia, *Algae, *Radioactive tracers, *Assimilative capacity, Food chains.

The efficiency of carbon assimilation in *Daphnia magna* was estimated as a function of the C14-labeling time of the food alga *Scenedesmus acutus*. The assimilation efficiency of C14 was up to 24% higher at low labeling times (< or = 1.4 generations) (*P* < 0.05) than at high labeling times (> or = 4.2 generations). In uniformly labeled cells the assimilation efficiency in *D. magna* was 71 ± 2% SE. Variation in the assimilation efficiency with labeling time is associated with change in the relative distribution of C14 among the different cell compartments in the food alga. Uniform labeling of algae is achieved effectively via exponential growth over several generations in batch cultures from sparse inocula. (Author's abstract) W90-05399

HUMIC CONTENT OF LAKE WATER AND ITS RELATIONSHIP TO WATERSHED AND LAKE MORPHOMETRY.

McGill Univ., Montreal (Quebec). Dept. of Biology.
J. B. Rasmussen, L. Godbout, and M. Schallenberg.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1336-1343, November 1989. 1 fig, 5 tab, 44 ref.

Descriptors: *Limnology, *Color, *Lakes, *Lake morphometry, *Organic matter, *Model studies, Dissolved solids, Regression analysis, Topography, Watersheds, Humic acids, Slopes.

The relationship of lake water color (milligrams/liter Pt) to watershed and lake morphometry, derived from topographical, hydrological, and bathymetric maps, was examined by log-linear multiple regression analysis on a data set obtained from 337 lakes from the northern United States and Canada. Color was positively related to the drainage ratio, and negatively related to watershed slope, mean lake depth, and lake area. Lakes that receive significant indirect drainage from other lakes were less colored than headwater lakes. The best regression model explained 60% of the variance in lake water color. Regression models were calculated separately for four geographic regions (the Laurentians of Quebec, eastern Quebec-Maine, northeastern Wisconsin, and the Experimental Lakes Area of western Ontario). The regression coefficients for the most significant variables, drainage ratio, watershed slope, and lake area, were similar over these four areas, but the regional models still had significantly smaller standard errors than the general model based on the whole data set. (Author's abstract) W90-05400

LOSS OF TOTAL SULFUR AND CHANGES IN SULFUR ISOTOPIC RATIOS DUE TO DRYING OF LACUSTRINE SEDIMENTS.

Manitoba Univ., Winnipeg. Dept. of Microbiology
D. A. Amaral, R. H. Hesslein, J. W. M. Rudd, and D. E. Fox.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1351-1358, November 1989. 3 fig, 2 tab, 17 ref. NSERC Grant A2671.

Descriptors: *Laboratory methods, *Sediments, *Chemical analysis, *Lake sediments, *Sulfur, *Stable isotopes, Pollutant identification, Sulfur compounds.

Two independent methods for measuring total sulfur were used to show that underestimates of sulfur content of lacustrine sediments can occur when sediments are dried before total sulfur analysis. Different types of sediments were oven dried at

60 or 100°C or lyophilized to assess the effect of the drying method on the amount of sulfur lost. Losses ranged from 0 to 86%. Common losses were 6-22% and dependent on the sample and drying method used. Lyophilization caused greater sulfur losses (1.5-fold) than the two oven-drying methods. These sulfur losses caused changes in the sulfur isotopic content of the sediments and could underestimate rates of sulfur burial in sediments, organic-S formation in sediments, and internal alkalinity production in lakes. (Author's abstract) W90-05402

PREDICTING CHANGES IN HYPOLIMNETIC OXYGEN CONCENTRATIONS WITH PHOSPHORUS RETENTION, TEMPERATURE, AND MORPHOMETRY.

McGill Univ., Montreal (Quebec). Dept. of Biology.
R. J. Cornett.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1359-1366, November 1989. 7 fig, 4 tab, 32 ref.

Descriptors: *Limnology, *Water pollution effects, *Oxygen requirements, *Phosphorus, *Lake sediments, *Mathematical models, *Hypolimnion, Temperature effects, Regression analysis, Statistical analysis, Lake morphometry, Nutrients.

A statistical analysis of the rate of change in oxygen concentrations (VOD, milligrams O₂/cu m/day) in 1-m-thick strata in the hypolimnion of 29 lakes suggests that these rates can be predicted from a knowledge of the annual retention of phosphorus by the lake sediments, the mean summer temperature of the stratum, and the morphometry of the stratum. VOD values increased as temperature and phosphorus retention increased. Rates were inversely proportional to the ratio of the volume of the stratum divided by the area of sediments that are contiguous to the stratum. The statistical model was tested by measuring VOD values in an independent group of 12 lakes. Predictions agreed well with the measured values. An analysis of the combined data explained 91% of the variance in VOD values. The regression correctly predicted the vertical variation in VOD values in lakes that exhibited negative heterograde, orthograde, and clinograde oxygen profiles. After further testing, this model should provide a method of predicting changes in oxygen concentrations in lakes that are subject to perturbations such as changes in temperature or nutrient loading. (Author's abstract) W90-05403

METAL FLUXES TO SWEDISH FOREST LAKES.

National Swedish Environment Protection Board, Solna. Trace Metal Lab.
For primary bibliographic entry see Field 5B.
W90-05414

METALS IN SEDIMENT OF LAKES IN NORTHERN SWEDEN.

National Swedish Environment Protection Board, Solna. Research Dept.
For primary bibliographic entry see Field 5B.
W90-05415

ATTACHMENT OF TOXIGENIC VIBRIO CHOLERAE 01 TO VARIOUS FRESHWATER PLANTS AND SURVIVAL WITH A FILAMENTOUS GREEN ALGA, RHIZOCLONIUM FONTANUM.

London School of Hygiene and Tropical Medicine (England). Dept. of Tropical Hygiene.
For primary bibliographic entry see Field 5B.
W90-05450

FACTORS INFLUENCING THE MICROSPATIAL ZOOPLANKTON AND OXYGEN HETEROGENEITY IN WLOCLAWEK DAM RESERVOIR.

Nicholas Copernicus Univ. of Torun (Poland). Inst. of Biology.

R. Wisniewski, and L. A. Bledzki.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 3-8, November 1989. 2 fig, 2 tab, 19 ref.

Descriptors: *Reservoirs, *Limnology, *Zooplankton, *Dissolved oxygen, *Spatial distribution, *Wloclawek Dam, *Poland, Horizontal distribution, Vertical distribution, Wind, Waves, Organic matter, Biological oxygen demand, Dams.

During the investigations conducted in Wloclawek Reservoir in 1980-85 considerable horizontal and vertical differentiation of physicochemical and biological parameters were found. The highest variability was observed in zooplankton and dissolved oxygen concentration. Close connection of zooplankton and oxygen heterogeneity with hydrological and meteorological factors-water discharge and wind-was shown. Wind influenced heavy waving affects resuspension of fine deposits rich in organic matter, and subsequent rise of BOD in the water by one order of magnitude. (Author's abstract)

W90-05451

SESTON VERTICAL FLUX MODEL FOR EUTROPHIC RESERVOIR.

Malaga Univ. (Spain). Dept. de Ecologia.

J. A. Galvez, F. X. Niell, and J. Lucena.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 9-18, November 1989. 6 fig, 2 tab, 37 ref.

Descriptors: *Reservoirs, *Seston, *Phytoplankton, *Vertical flow, *Limnology, *Eutrophic lakes, *Sedimentation, *Mineralization, Thermocline, Spain, Primary production, Eutrophication.

During stratified periods, seston vertical flux was estimated by means of sediment traps positioned at different depths in the water column of a eutrophic reservoir in southern Spain (Marbella, Malaga). At the same time the in vitro phytoplankton flux was estimated at the same levels and under the same conditions. A model of seston sedimentation, including fragmentation and mineralization as important control factors of seston bottom influx, was constructed. Phytoplankton flux contributes in a high percentage to the epilimnion seston flux. In the hypolimnion, the phytoplankton flux is smaller. Sedimentary mechanisms are quantitatively controlled by primary production. Flux decreases with depth by mineralization during sedimentation, especially at the thermocline level. This causes nutrient regeneration which can support large populations of newly produced algae. (Sand-PTT)

W90-05452

STRUCTURE PECULIARITIES AND VARIABILITY OF THE TEMPERATURE RANGE IN RESERVOIRS.

Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.

N. V. Butorin, and A. S. Litvinov.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 27-33, November 1989. 3 fig, 2 tab, 6 ref.

Descriptors: *Limnology, *Reservoirs, *Water temperature, *Stream discharge, *Water exchange.

Factors determining the temperature regime of reservoirs are their radiation balance, dependent on the geographic position, water dynamics (intensity of the external and internal water-exchange), morphometric peculiarities of the basin structure and the influence of economic activities. The temperature field of any reservoir should be considered as a part of its physical system characterizing the heat distribution within the water column and itself strongly subject to spatial inhomogeneity and temporal variability. The following types of inhomogeneities can be recognized in the areas of reservoirs: (1) drastic temperature fluctuations in the zone of hydrologic fronts; (2) inhomogeneities of the order of several kilometers (large scale); (3) inhomogeneities ranging from several hundreds of meters to 1-2 km (large scale); (4) small scale inhomogeneities ranging from a few meters to tens of meters. The most significant (in amplitude)

water temperature fluctuations are usually observed in the region of hydrological fronts. Hydrological fronts in reservoirs are associated with water storage of some phases of the river discharge and their subsequent transformation. The complexity of the water mass structure in reservoirs is dependent on the morphological construction and water exchange intensity. The simplest structure is typical of channel reservoirs and the most multicomponent, as in morphologically complicated reservoirs is typical, of long-term stream flow control. (Sand-PTT)

W90-05454

WATER AND MASS EXCHANGE IN THE LAKE BAIKAL AND STORAGE RESERVOIRS OF THE ANGARA CASCADE.

Limnologicheskii Inst., Irkutsk (USSR).

V. I. Verbov, V. N. Sinyukovich, and N. L. Karpysheva.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 35-40, November 1989. 1 fig, 4 tab, 13 ref.

Descriptors: *Lakes, *Storage reservoirs, *Lake Baikal, *Water exchange, *Water circulation, Hydroelectric plants, Flow, Wind-driven currents, Diffusion, Seasonal variation, Tritium, Anagara River.

Creation of man-made storage reservoirs results in slowing down of the water circulation in the ocean-atmosphere-land system, an increase in the time period for water inflow into inland and external seas, and an annual redistribution of river runoff flow with certain changes in its qualitative composition. These phenomena have been observed in the water reservoirs of the Angara cascade. Construction of the Irkutsk hydropower plant caused an increase of the Baikal level by one meter as compared to the mean multiyear level; the amplitude of its seasonal fluctuations increased; the start of high-level and low-level waters shifted a month, though on the whole the regime of water level fluctuations in the lake is close to the natural one. Creation of reservoirs on the Angara river resulted in both a decrease of water exchange rates and changes in the nature of physical, chemical, and biological processes occurring in the water. Analysis of the external water exchange duration, calculated as a ratio of mean annual volume of water mass and water discharge (runoff plus evaporation) showed that the water exchange regime in Lake Baikal after its regulation had not practically changed and was about 327 years. Hydrological conditions influencing the functioning of the reservoir geobiosystem have an essential effect on external and internal water exchange. The latter is realized by flows, wind-driven current and diffusion. Data on tritium distribution in the northern part of the lake have shown that (1) water at different depths can be of different concentrations for a long time; (2) with weak mixing such waters can penetrate up to the bottom layers; (3) impact on the quality of surface waters in the catchment area can be displayed in the deep water layers in real rather than geological time scales. The construction of reservoirs on the Angara river substantially changed conditions for forming water masses. This is expressed mainly by the increase of water residence time under conditions of slow water exchange. (Sand-PTT)

W90-05455

HORIZONTAL DISTRIBUTION OF LIMNOLOGICAL VARIABLES IN RIMOV AND OTHER STRATIFIED CZECHOSLOVAK RESERVOIRS.

Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.

J. Hejzlar, and M. Straskraba.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 41-55, November 1989. 9 fig, 2 tab, 11 ref.

Descriptors: *Reservoirs, *Thermal stratification, *Water temperature, *Chemical stratification, *Limnology, Horizontal distribution, Streamflow, Dissolved oxygen, Chemical oxygen demand, Density currents, Color, Floods, Czechoslovakia.

For the drinking water supply Rimov Reservoir the annual cycle of the horizontal distribution of temperature, dissolved oxygen, chemical oxygen demand and color is described. It is related to the inflow stream determination based on the temperature-related density difference of the inflowing stream and the reservoir water. Detention time of the inflowing water (time to reach the dam) is estimated for a few instances when a natural chemical marking of the inflow during floods occurred. Both the thawing and freezing of the reservoir starts at headwaters and continues down the reservoir. To compare the schematic cycle observed in Rimov with other Czechoslovak reservoirs, the inflow-surface-bottom density difference cycles and the resulting inflow stream were analyzed for a few other reservoirs. The figures obtained by direct comparison of temperatures are not different from those obtained from density estimates. The horizontal distribution is different depending on theoretical retention time of water in the given reservoir and year. From empirical models of river and reservoir temperatures, it follows that additional variables like surface elevation, outlet location and watershed characteristics will play a role, as well as hydrometeorological conditions of the specific year. (Author's abstract)

W90-05456

SIMULATING THE THERMAL STRUCTURE OF PLESHCHEEVO LAKE.

Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.

L. A. Kuchaev.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 57-62, November 1989. 3 fig, 9 ref.

Descriptors: *Lakes, *Water temperature, *Temperature gradient, *Limnology, *Hydrologic models, *Thermal stratification, Temporal distribution, Vertical distribution, Mathematical models, Simulation, Lake Pleshchevo, USSR.

A two-layer approximation model was used to describe the vertical temperature profile of Lake Pleshchevo in 1983-1985 from May to October, including the periods of spring and autumn homothermy and summer stratification. Spring homothermy was taken as initial conditions. The lake's bottom was taken as the lower boundary of the thermocline. Two types of dimensionless profiles resulting from the data analysis were approximated by polynomials of the fourth degree. Temperature and wind speed information were presented by their average daily values. Simulating results of temperature distribution have shown that the model correctly reflects the basic trends of the lake's temperate structure. This model is an independent module in the general model of the Lake Pleshchevo ecosystem. (Sand-PTT)

W90-05457

APPLICATION OF A LAKE THERMAL STRATIFICATION MODEL TO VARIOUS CLIMATIC REGIMES.

New South Wales Univ., Kensington (Australia). School of Information Systems.

B. Henderson-Sellers, and K. H. Reckhow.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 71-78, November 1989. 5 fig, 11 ref.

Descriptors: *Lakes, *Thermal stratification, *Reservoirs, *Climatic zones, *Limnology, *Hydrologic models, Subtropical zone, Mathematical models, Simulation, Bathymetry, Turbidity, England, Canada, South Africa.

Existing models of thermal stratification in lakes have often been designed for a single application/case study and consequently frequently include tuning coefficients to permit simulation of any specific data set. One technique to ensure the model's wider applicability is to utilize observational data sets from a wide range of sites so that each parameter may be assessed for its significance. For example, the impact of flood or drought events is difficult to assess from solely north temperate data as a result of the rarity of such events

Field 2—WATER CYCLE

Group 2H—Lakes

in the time series, whereas South African data includes an annual cycle of inundation and drought. The model EDD1 (Eddy Diffusion Dimension 1) is intended to be one such generalized model which can be used for different lakes/reservoirs without prior calibration. The global nature and transferability of this stratification model is exemplified by its application to three separate climatic regimes: north temperate maritime (U.K.); north temperate continental (Ontario, Canada) and subtropical (South Africa). In all three cases the model has been used to simulate the observations without tuning of any parameters. Simulations require only lake-specific bathymetry, water turbidity and local meteorological data, all of which can be derived from standard hydrometeorological observation networks. (Author's abstract) W90-05458

HEAT BUDGET OF A HIGH MOUNTAIN RESERVOIR IN THE CENTRAL PYRENEES.

Barcelona Univ. (Spain).

A. Palau.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 79-90, November 1989. 5 fig, 3 tab, 12 ref.

Descriptors: *Reservoirs, *Heat budget, *Air-water interfaces, *Water temperature, *Limnology, *Hydroelectric plants, *Baserca Reservoir, *Thermal properties, Solar radiation, Thermal radiation, Evaporation, Snowmelt, Pyrenees Mountains, Spain.

The heat budget (defined as the difference between the highest and lowest heat content during the same annual cycle) of Baserca Reservoir in the Central Pyrenees in Spain was investigated. The different estimated values in relation to the air-water interface (direct solar radiation, reflected radiation from the reservoir surface, water evaporation, thermal radiation from the atmosphere, and thermal radiation from the water) follow the expected general distribution according to meteorological changes. The horizontal transport of heat through the tributaries and the hydraulic management of the reservoir involve the highest percentages of inputs and outputs of heat. The snow dependent character of tributaries with a marked period of melting between May and July affects the thermal regime of the reservoir through the water turnover; thus, the maximum volume of outflow through the Baserca Power Station coincides with the period of melting, and so the thermocline is weak, descending rapidly and remaining at considerable depth during the summer. The thermal cooling effect of water exchange with Llauset Lake is very clear. In spite of the fact that the transferred volumes of water in the two directions have been similar and that during the summer of 1985 no water was pumped from the reservoir, the heat loss is significantly greater than the heat input by the turbined water from the lake. The difference in the thermal regime between the reservoir and this lake as a result of their difference in height meant that the turbined water from Llauset to the reservoir was usually much colder than the water pumped in the opposite direction. Among the terms which have not been taken into account, the most important are the conduction of heat through the sediments and the dam. (Sand-PTT) W90-05459

LIMNOLOGY OF A SUBALPINE PUMP-STORAGE RESERVOIR: II. QUANTIFICATION OF VERTICAL MASS AND ENERGY FLUXES USING A DYNAMIC MODEL.

Zurich Univ., Kilchberg (Switzerland). Hydrobiological-Limnological Station.

B. Kiefer, and D. Imboden.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 95-105, November 1989. 9 fig, 2 tab, 2 ref.

Descriptors: *Pump storage, *Storage reservoirs, *Limnology, *Model studies, *Energy transfer, *Water temperature, *Mathematical models, *Simulation, Nutrients, Phosphates, Wagitalersee, Switzerland, Mountain lakes, Primary productivity, DYRESM, Hydrologic models.

In order to quantify the vertical mass and energy fluxes of a subalpine pump-storage reservoir, the one-dimensional dynamical temperature simulation model DYRESM was extended. Subroutines describing the intrusion of the pumped water and the nutrient supply to the euphotic layer by natural and artificial flows were added. The model was calibrated using selected data from a data set obtained from an investigation in the Wagitalersee. The accuracy of the calibrated model was tested by comparing the simulated and measured lake temperatures over the whole investigation period. These temperatures differed little from one other. The surface temperature differed at most by 3°C (average difference 0.04°C). The maximum difference in the rest of the depth profile was only 2°C. It may therefore be assumed that the vertical mass and energy fluxes are realistically simulated. Pump-storage reservoirs act during spring and summer as very efficient energy traps. Pump-storage causes a strong recirculation of nutrients (phosphates) from the lake's depth to the euphotic layer. The mechanisms that lead to these phenomena can be quantified exactly using the model. DYRESM has proved to be a very powerful tool in simulating the vertical mass and energy fluxes in a reservoir with pump-storage operation. The model can easily be extended to simulate nutrient sedimentation and primary production. With such a model it should be possible to estimate quantitatively the effects of water management changes on the primary production of small to medium size pump-storage reservoirs. (Sand-PTT) W90-05460

THERMAL REGIME OF LAKE DRUKSIAI.

Akademiya Nauk Litovskoi SSR, Vilnius. Inst. of Zoology and Parasitology.

E. Zukaitis, and B. Pernaševiciute.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 107-111, November 1989. 2 fig, 1 ref.

Descriptors: *Lakes, *Nuclear powerplants, *Cooling ponds, *Temperature effects, *Thermal water, *Water temperature, Lake Druksiai, USSR.

Important changes have occurred in the thermal regime of the cooling pond of Lake Druksiai (Lithuania, USSR) since the start of operation of the Atomic Power Station in 1984. The temperature has risen both in the surface layers as well as the near bottom water layers, confirmed by the increase in depth of the epilimnion and the thermal zone $T > 15^\circ\text{C}$. Conversely, the zones $T < 15^\circ\text{C}$ and 10°C decreased, and the zone $T < 8^\circ\text{C}$ disappeared totally. These changes became even more noticeable in winter, where the temperature had risen by 1.3 to 3.8°C . Consequently, the changes of thermal regime of Lake Druksiai have resulted in gradual alterations of ecological conditions for the aquatic organisms. (Sand-PTT) W90-05461

SENSITIVITY OF THERMOCLINE MODELS TO PARAMETRISATIONS OF THE SURFACE ENERGY BUDGET AND OF WIND MIXING.

New South Wales Univ., Kensington (Australia). School of Information Systems.

B. Henderson-Sellers.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 113-122, November 1989. 2 fig, 2 tab, 14 ref.

Descriptors: *Limnology, *Model studies, *Lakes, *Thermocline, *Thermal stratification, *Energy, Mathematical models, Simulation, Wind, Air temperature, Cloud cover, Error analysis, Hydrologic models.

Simulations of the thermal structures of lakes and other water bodies rely on the input of a large body of data, mostly meteorological, as boundary conditions to the model. Perturbations to a range of meteorological and limnological variables were imposed on the thermal stratification model EDD1 (Eddy Diffusion Dimension 1, which utilizes an eddy diffusion coefficient in order to close the non-linear heat conduction equation) in order to assess for which of these many variables errors in the input data could be problematical. The results sug-

gest that the most important parameters are, generally, air temperature and cloud cover. In specific situations other parameters may also be important, e.g. changes in wind speed in cases of low wind speed, and changes in extinction coefficient (a measure of water turbidity) in lakes which may be classified as oligotrophic or mesotrophic—although not those which are eutrophic. (Author's abstract) W90-05462

INDUCED SURFACE FLOW IN A MODEL RESERVOIR.

Calgary Univ. (Alberta). Dept. of Chemical and Petroleum Engineering.

M. F. Mohtadi, M. E. Di Capua, and K. K. Leung. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 123-134, November 1989. 11 fig, 1 tab, 4 ref.

Descriptors: *Hydraulic models, *Reservoirs, *Surface flow, *Hydraulics, *Flow velocity, *Barriers, *Weirs, Flow pattern, Oxygen transfer, Model studies.

A novel method, which can induce surface flow in a model reservoir without the need for mechanical energy, utilizes the positioning of a solid barrier upstream of the sluice gate of the reservoir. Experiments were designed to yield surface path lines, surface velocities and subsurface flow patterns in a model with and without the barrier. Tracer beads, time-lapse photography, and dye injection techniques were used for visualization of flow patterns. The results clearly showed that with the barrier in place, the surface velocities were appreciably greater than the corresponding values without the barrier. Such comparatively fast movements at the surface can help to break up stagnant surface films and reduce the interfacial resistance to oxygen transfer from the air to the water. (Author's abstract) W90-05463

VERIFICATION OF ONE PREDICTIVE MODEL FOR RADIATION COMPONENTS UNDER THE CONDITIONS OF A RIVER RESERVOIR.

Vyskumny Ustav Vodohospodarsky, Bratislava (Czechoslovakia).

M. Rudis, and V. Matousek.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 135-142, November 1989. 3 fig, 5 ref.

Descriptors: *Reservoirs, *Solar radiation, *Model studies, *Heat transfer, *Water temperature, *Thermal properties, *Thermal stratification, *Flow rates, Mathematical models, Orlik Reservoir, Vltava River, Czechoslovakia.

Two predictive models for radiation components under river reservoir conditions were examined. The first method derives predictive relations for heat transfer through the free surface using the direct measurements of radiation components. The second method derives new predictive formulae for radiation taking into account the ground visibility and index of cloudiness. Using both methods, the heat content corresponding to the heat income through the free surface of a river reservoir was computed and the results were compared with the respective heat content obtained from independent measurements of temperatures and flow rates in the Orlik Reservoir on the Vltava River Czechoslovakia. The results were plotted using two methods: (1) predicted points based on the seven year mean of the determined heat flows; and (2) predicted points computed on the basis of annual means. The predicted points on the basis of the respective yearly means appear to be much more spread along the independent relation than those using the seven year means. Both predictive methods show smaller values at the beginning of the stratification period and greater values before its end, while the method which takes into account ground visibility and cloudiness shows a systematic error of about 15%. Taking into account that this model contains, besides meteorological variables (which can be inputted in long-time means), only the surface temperature of water, the model provides a good tool

for prediction of thermal behavior of large river reservoirs under central European conditions. (Sand-PTT)
W90-05464

POST-IMPOUNDMENT ASSESSMENT OF THE OSTROFSKY-DUTHIE MODEL FOR RESERVOIR MATURATION.

Waterloo Univ. (Ontario). Dept. of Biology. S. Han, and H. C. Duthie. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 143-145, November 1989. 1 tab, 11 ref.

Descriptors: *Limnology, *Reservoirs, *Lakes, *Phosphorus, Mathematical models, Chlorophyll a, Soil chemistry, Vegetation, Labrador, Canada.

The impact of reservoir development has been studied through the modeling of maturation processes which follow impoundment. The Ostrofsky-Duthie model for predicting the magnitude and duration of trophic changes in newly flooded reservoirs predicts phosphorus concentrations (P) in a lake based on phosphorus loading, retention and discharge according to the formula $P = J(1-R)/Q$, where J is the phosphorus loading, R is the retention coefficient, and Q is the total discharge. The budget was tested for lakes in the Labrador region as well as in the Smallwood Reservoir, and it was found to be a good predictor of phosphorus concentration, except in the reservoir where phosphorus was consistently underestimated. As all of the lakes were similar geologically, biologically and chemically, it was assumed that there was a source of phosphorus in the reservoir which was unaccounted for in the model for lakes. It was suggested that inundated soils and vegetation were a source of phosphorus loading in the reservoir that was not present in natural lakes. Examination of data from a natural lake (Mile 83) and two reservoirs (Gabbro and Lobstick) for 1976 and 1986 shows that total phosphorus concentrations have risen, corresponding to the higher turnover times found in 1986. Lowered chlorophyll-a values may be related to the longer turnover times. This indicates a possible change in phosphorus-chlorophyll ratios. (Sand-PTT)
W90-05465

NUMERICAL EXPERIMENTS WITH A MATHEMATICAL MODEL OF PHOSPHORUS CYCLING IN THE EPIPLIMNION OF LAKE GLEBOKIE.

Polish Academy of Sciences, Warsaw. Zaklad Paleobiologii. For primary bibliographic entry see Field 5B.
W90-05466

PHOSPHORUS TRANSFORMATION AND WATER QUALITY IN THE IVANKOVO RESERVOIR: STUDY BY MEANS OF A SIMULATION MODEL.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem. For primary bibliographic entry see Field 5C.
W90-05467

MODELLING OF ORGANIC PARTICLE FLUX THROUGH THE METALIMNION IN LAKES.

Polish Academy of Sciences, Warsaw. Zaklad Paleobiologii. W. Szeligiewicz. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 169-177, November 1989. 3 fig, 3 ref, append.

Descriptors: *Lakes, *Metalimnion, *Organic matter, *Thermocline, *Water temperature, *Mathematical models, Vertical flow, Sedimentation.

Whether the changes of flux of organic particles in the metalimnion due to changes of slope of the thermocline calculated according to a one-dimensional model based on the AQUAMOD model could agree with Gliwicz's hypothesis about the influence of metalimnetic temperature gradient on the vertical flux of organic particles was examined.

The Gliwicz hypothesis suggests that the sharper the vertical temperature gradient in the metalimnion, the greater is the decrease of sedimentation speed of the particles. The results showed that a decrease of sedimentation speed in the metalimnion is not a necessary condition (in the steady-state) to model the decrease of the transition coefficient T_s and FW-h due to an increase in the slope of the thermocline (where FW-h is the flux of mass from the metalimnion to the hypolimnion and T_s is the ratio of FW-h to the flux of the organic particles from the epilimnion). The direction of changes in T_s , FW-h and rate of nutrient release in the metalimnion depend on the particular relationships used in the model and on the way the temperature profile modification is related to changes in the temperature gradient of water in the metalimnion. If the model includes the mechanisms which are responsible for changes of the flux in real lakes, then the Gliwicz hypothesis could be used as an additional criterion for the choice of proper relationships describing these mechanisms. (Sand-PTT)
W90-05468

SIMULATED IMPACTS OF FLOW REGULATION ON BLUE-GREEN ALGAE IN A SHORT RETENTION TIME LAKE.

Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering. For primary bibliographic entry see Field 5G.
W90-05469

MINIMAL SAMPLING SCHEDULE FOR A DYNAMIC LAKE MODEL.

Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering. For primary bibliographic entry see Field 7A.
W90-05470

ANALYSIS OF IMPROVED PARAMETER ESTIMATION IN LAKE MODELLING.

Politechnika Warszawska (Poland). Inst. of Environmental Engineering. For primary bibliographic entry see Field 7C.
W90-05471

MODELLING INTERNAL AND EXTERNAL CONTROL IN LAKE AND RESERVOIR ECOSYSTEMS.

Ceskoslovenska Akademie Ved, Prague. Ustav Teorie Informace a Automatizace. L. Bakule, and M. Straskraba. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 213-214, November 1989. 6 ref.

Descriptors: *Lakes, *Limnology, *Reservoirs, *Ecosystems, *Mathematical models, Phosphorus, Phytoplankton, Zooplankton, Eutrophication, Game theory, Control theory.

Hierarchical control theory has been suggested as an adequate tool for both internal and external aquatic ecosystem control. The mathematical principles of the three different structural control strategies were evaluated: a two-level discrete time multiobjective optimization strategy, the sequentially extended objective function strategy, and a scalar value objective function strategy based on game theory approach. A simplified theoretical dynamic model of the pelagic trophic food chain was used for control formulations. The basic discrete-time model consists of equations for phosphorus, phytoplankton and zooplankton. The budget terms represent a simplified version of the model AQUAMOD I. The two-level multiobjective optimization strategy is based on the decomposition-coordination control approach. One level is represented by the natural ecosystem; the second level relates to man's control, aiming in the case of eutrophication to reduce algal biomass below prescribed limits at minimum costs. The game principle allows the mutual reactions of the participants on the other participants' control strategy to be expressed. The leader-follower open loop control strategy was applied. It was assumed that the

leader is represented by man's control, and the follower by nature reacting to man's move. For the internal control problem it can be assumed that the higher trophic element represents the leader (coordinator), because it has more elaborate sensors. With the sequentially extended objective function strategy, instead of using an integral goal formulation, a local optimum for each instant of time is calculated. Maximization of energy flow in the total system is the goal. Constraints are represented by saturation effects, food preferences and donor limits. Graph theory is used to represent food webs and to apply the ecological concept of optimal foraging. (Sand-PTT)
W90-05472

SIMULATION OF RESERVOIRS IN A GLOBAL DESCRIPTION OF MOVEMENT OF POLLUTION IN THE ENVIRONMENT.

Research Inst. of Fuel and Energy Complex, Prague (Czechoslovakia). For primary bibliographic entry see Field 5B.
W90-05473

INFLUENCE OF RESERVOIRS ON THE HYDROLOGICAL REGIME OF THE KUR RIVER.

Akademiya Nauk Azerbaizhdzhanskoi SSR, Baku. Inst. of Geography. For primary bibliographic entry see Field 4A.
W90-05474

BACTERIAL UTILIZATION OF PHOTOSYNTHETICALLY PRODUCED DISSOLVED AND PARTICULATE ORGANIC MATTER AND THE ROLE IN C-FLUX OF LAKE STECHLIN.

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie. C. Babenzien, and H.-D. Babenzien. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 225-235, November 1989. 7 fig, 2 tab, 27 ref.

Descriptors: *Oligotrophic lakes, *Aquatic bacteria, *Carbon cycle, *Dissolved solids, *Limnology, *Particulate matter, *Phytoplankton, *Algae, *Primary productivity, *Organic matter, Detritus, Carbon radioisotopes, Photosynthesis, Mineralization, Lake Stechlin, East Germany.

A study was conducted to quantify the microbial capacity in relation to primary production in C-flux of oligotrophic Lake Stechlin. In situ studies of the bacterial uptake of dissolved organic substances formed by phytoplankton release during photosynthesis and water extraction of dead phytoplankton were used as the reference methods. Primary production, exudation, and bacterial assimilation of exudates were measured with the C-14 method and a particle size fractionation technique. Production of C-14 CO₂ was employed as an estimate of the mineralization rate. With natural phytoplankton populations average exudation rates of 50% in the oligotrophic Lake Stechlin and 20% in the eutrophic Lake Dagow were obtained. On average 20% and 8% of the primary production respectively was assimilated by the bacterial population in the two lakes. Forty to 90% of the bacterial production was based on the utilization of exudates. Regarding the degradation of particulate phytoplankton debris, mineralization rates of about 7% per day were obtained in both lakes. These results show the significance of the close coupling between algae and bacteria in view of the carbon metabolism of lakes. (Author's abstract)
W90-05475

RESPONSES IN BACTERIAL ACTIVITY TO CHALLENGING CONDITIONS IN PLANKTON—PROBABLE CONTROLLING MECHANISMS.

Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology. K. Simek, C. Budejovice, and J. K. Fуска. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 239-248, November 1989. 2 fig, 3 tab, 24 ref.

Field 2—WATER CYCLE

Group 2H—Lakes

Descriptors: *Aquatic bacteria, *Bacterial physiology, *Zooplankton, *Limnology, *Phytoplankton, *Photosynthesis, *Metabolism, Seasonal variation, Bacterial analysis, Reservoirs, Fish ponds, Diel cycle, Amino acids, Glucose, Carbon radioisotopes, Tritium.

Parameters of total activity of bacterioplankton were determined by means of C-14-glucose uptake and the incorporation of tritiated amino acids. Seasonal changes of the bacterial plankton changes were studied in the Rimov reservoir in Southern Bohemia, Czechoslovakia and diel changes in a fishpond. Parameters of individual activity were determined by the autoradiographic method using thymidine (% of metabolizing cells) and tritiated thymidine (% of 'probably dividing' cells) during both seasonal and diel cycles. A close relationship was found between microbial activity and the diel cycle of photosynthesis. On a seasonal time-scale, significant relationships were found between counts of metabolizing bacteria and phytoplankton biomass. The relationship between the former and the biomass of Cladocera was even more significant. Two mechanisms are suggested to explain sensitive responses of the bacterioplankton activity to changing ambient conditions: changes in the proportion of active cells not exceeding one order of magnitude, and changes in individual cell activity exceeding two orders of magnitude. (Author's abstract)

W90-05476

MODEL OF SEASONAL CHANGES IN PLANKTONIC BACTERIA RELATED TO PHYTO- AND ZOOPLANKTON.

Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.

V. Straskrabova, and C. Budejovice.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 249-255, November 1989. 3 fig, 1 tab, 20 ref.

Descriptors: *Reservoirs, *Aquatic bacteria, *Phytoplankton, *Zooplankton, *Limnology, *Algae, Primary productivity, Bacteria, Seasonal variation.

On the basis of long-term observations on three reservoirs, the average seasonal changes of bacterial biomass and their specific activities were derived and related to seasonal dynamics of phytoplankton production and phyto- and zooplankton biomass. Five phases in the development of planktonic bacteria are distinguished, which differ both in the sources of their prevailing substrate and the degree of their elimination by zooplankton. Phase I, in early spring, is characterized by an increase of bacterial biomass and growth rate occurring simultaneously with the increase of phytoplankton biomass and primary production. Zooplankton biomass is low and both the elimination of bacteria and the substrate input from zooplankton excrements are negligible. Phase II, in early summer, is the period of decline, first of phytoplankton and then of bacterial biomass. Algae are efficiently consumed by the increasing biomass of filtering zooplankton. The substrate supply for bacteria is low and their yield decreases; bacteria are eliminated by zooplankton. During phase III, mid-summer, the second peak of algae and bacteria occurs at a high level of filtering zooplankton. The summer algal peak is formed by less edible species. Consequently, zooplankton excrements are energy-rich, providing a significant substrate source for bacteria. Bacterial growth rates and the ratio of production to respiration increases. In phase IV, from late summer to autumn, a decline of phytoplankton is characterized by a slow further increase of bacteria and slow decrease of zooplankton. The bacterial growth rate gradually decreases together with decreasing yield. Phase V is a period of low winter biomass of all planktonic components. The main substrate source for bacteria is slowly degradable dissolved organic substances, the background source. Towards the end of the period (end of winter, early spring) bacterial mortality is observed to coincide with spring overturn, temperature increase and the commencement of phytoplankton activity. (Sand-PTT)

W90-05477

NUMBER AND ACTIVITY OF MICROORGANISMS AT THE SEDIMENT WATER INTERFACES OF LAKES.

Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.

A. N. Butorin.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 259-263, November 1989. 3 tab, 10 ref.

Descriptors: *Limnology, *Bacteria, *Lakes, *Sediment-water interfaces, *Aquatic bacteria, Carbon dioxide assimilation, Organic matter, Hydrogen ion concentration, Water temperature, Microbiological studies.

The bacteria in the sediments of 21 lakes of different trophic status were investigated using dark CO₂ assimilation as a measure of activity. The number and activity of bacteria increased greatly in the transition from the overlying water to the surface of the sediments. The total number of bacteria at the sediment-water interface was 2 orders greater and the CO₂ assimilation was 2-3 orders greater than in the prebottom water. The difference between the surface film and the deeper layers was not as great: 1.5-2.0 times greater at the surface. The greatest difference in the mean numbers of bacteria at the interface and in the deeper layers of sediments was observed in chthonotrophic lakes (6.6 times) and that of the mean value of activity in mesotrophic lakes (7.3 times). This difference, as well as the number of bacteria and activity, varied greatly from lake to lake, depending on the character of the water bodies and their sediments. The lowest numbers of bacteria and CO₂ assimilation were observed in the surface film of sediments of oligotrophic lakes, which were considerably poor in organic matter. With the increasing productivity of the lakes and the amount of organic matter in the sediments, the number and activity of bacteria also increased. In dystrophic lakes, the total number of bacteria at the sediment-water interface was much greater than in lakes with high productivity. This correlated with a very high organic matter content. The microbial activity in the sediments of these lakes, however, was rather low, especially in chthonotrophic lakes. This can be explained by the low content of readily degradable organic matter, anaerobic conditions, low temperature and pH values. In chthonotrophic lakes the activity of benthic microflora was about 2 orders higher than in oligotrophic lakes. The sediment-water interface in the different types of lakes is the zone of a very high number and activity of microorganisms. The microbiological parameters depend on the character of the sediments, mainly the amount and quality of organic matter, which in turn depend on the productivity of the lakes. (Sand-PTT)

W90-05478

PARTICULATE ORGANIC MATTER AND ITS ROLE IN THE FORMATION OF WATER QUALITY IN LAKE SEVAN (ARMENIA).

Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.

L. O. Glushchenko.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 265-271, November 1989. 2 fig, 2 tab, 12 ref.

Descriptors: *Limnology, *Eutrophication, *Lakes, *Water quality, *Particulate matter, *Organic matter, *Phytoplankton, *Primary productivity, Seasonal variation, Chlorophyll a, Lake Sevan, Armenia.

The factors affecting particulate organic matter (POM) content in Lake Sevan were studied. The main source of POM is plankton primary production (PP); the portion of allochthonous POM (rivers, precipitation, aeolian drift) does not exceed 10% plankton primary productivity. The two year's comparison (1982-83) between POM and chlorophyll a concentration shows that spring and autumn maxima of POM are caused by phytoplankton vegetation. The retrospective estimation of POM contents in Lake Sevan during eutrophication is given. The lake level decrease caused an increase in the contribution of resuspension, as calculated by an empirical formula. (Author's abstract)

W90-05479

MICROBIOLOGICAL STUDIES OF LAKE ACIDIFICATION: TOXICOLOGICAL IMPLICATIONS.

National Water Research Inst., Burlington (Ontario).

For primary bibliographic entry see Field 5C. W90-05480

TRANSDUCTION OF LINKED CHROMOSOMAL GENES BETWEEN PSEUDOMONAS AERUGINOSA STRAINS DURING INCUBATION IN SITU IN A FRESHWATER HABITAT.

Stritch School of Medicine, Maywood, IL. Dept. of Biochemistry.

D. J. Saye, O. A. Ogunseitan, G. S. Saylor, and R. V. Miller.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 140-145, January 1990. 3 fig, 5 tab, 18 ref. EPA cooperative agreement CR815234.

Descriptors: *Aquatic bacteria, *Limnology, *Bacterial physiology, *Pseudomonas, *Bacteriophage, *Aquatic habitats, Genetics, Transduction, Lysogeny.

Both transduction of single chromosomal loci and cotransduction of closely linked loci were observed between lysogenic and nonlysogenic strains of *Pseudomonas aeruginosa* in a freshwater habitat. Transductants were recovered at frequencies of 0.00001 to 0.0001 transductants per colony forming unit (CFU). Transductants of lysogenic strains were recovered 10-fold to 100-fold more frequently than were transductants of nonlysogenic parents. Lysogens are thus capable of introducing phases which mediate generalized transduction into the natural microbial community and serving as recipients of transduced DNA. It would appear that lysogeny has the potential of increasing the size and flexibility of the gene pool available to natural populations of bacteria. The ability to generate and select new genetic combinations through phase-mediated exchange can be significant in the face of a continually changing environment and may contribute to the apparent fitness of the lysogenic state in natural ecosystems. (Author's abstract)

W90-05483

EFFECTS OF ACID STRESS ON AEROBIC DECOMPOSITION OF ALGAL AND AQUATIC MACROPHYTE DETRITUS: DIRECT COMPARISON IN A RADIOCARBON ASSAY.

Georgia Univ., Athens. Inst. of Ecology.

S. A. Schoenberg, R. Benner, A. Armstrong, P. Sobczyk, and R. E. Hodson.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 237-244, January 1990. 5 fig, 5 tab, 30 ref. U.S. Department of Energy contract DE-AC09-76SROO-819.

Descriptors: *Detritus, *Acid rain effects, *Acidic water, *Decomposing organic matter, *Phytoplankton, *Algae, *Macrophytes, Lakes, Swamps, Salt marshes, Lignocellulose, Hydrogen ion concentration, Okefenokee Swamp, Sapelo Island, Georgia, Aerobic decomposition.

Radiolabeled phytoplankton and macrophyte lignocelluloses were incubated at pH 4 and 7 in water from a naturally acidic freshwater wetland (Okefenokee Swamp; ambient pH, 3.8 to 4.2), a freshwater reservoir (L-Lake; pH 6.7 to 7.2), and a marine marsh (Sapelo Island; pH ca 7.8). The data suggest that acidity is an important factor in explaining the lower decomposition rates of algae in Okefenokee Swamp water relative to L-Lake or Sapelo Island water. The decomposition of algal substrate was less sensitive to low pH (ca 5 to 35% inhibition) than was the decomposition of lignocellulose (ca 30 to 70% inhibition). The substrate-dependent differences were greater and more consistent in salt marsh than in L-Lake incubations. In both freshwater sites, the extent to which decomposition was suppressed by acidity was greater for green algal substrate than for mixed diatom or blue-green algal

(cyanobacterial) substrates. The use of different bases to adjust pH or incubation in a defined saltwater medium had no significant effect on substrate-dependent differences. Although pH differences with lignocellulose were larger in marine incubations, amendment of lakewater with marine bacteria or with calcium, known to stabilize exoenzymes in soils, did not magnify the sensitivity of decomposition to acid stress. (Author's abstract) W90-05487

CLIMATIC AND HYDROLOGIC EFFECTS ON THE REGENERATION OF POPULUS ANGUSTIFOLIA JAMES ALONG THE ANIMAS RIVER, COLORADO.

Wisconsin Univ.-Madison. Dept. of Geography. For primary bibliographic entry see Field 2I. W90-05490

NUTRIENT CYCLING AT THE LAND-WATER INTERFACE: THE IMPORTANCE OF THE RIPARIAN ZONE.

Oregon State Univ., Corvallis. Dept. of Rangeland Resources. For primary bibliographic entry see Field 4C. W90-05501

MANAGEMENT IMPLICATIONS FOR RIPARIAN DOMINANCE TYPES OF MONTANA.

Montana Univ., Missoula. School of Forestry. For primary bibliographic entry see Field 6B. W90-05504

HABITAT USE BY BEAVER ALONG THE BIG SIOUX RIVER IN EASTERN SOUTH DAKOTA.

South Dakota State Univ., Brookings. Dept. of Wildlife and Fisheries. C. D. Dieter, and T. R. McCabe. IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 135-140. 2 fig, 55 tab, 23 ref.

Descriptors: *Riparian vegetation, *Land management, *Water resources management, *Water law, *Trees, *Riparian land, *Beavers, *South Dakota, *Animal behavior, Grazing, Castor, Vegetation re-growth.

Habitat use by beavers *Castor canadensis* was investigated during 1985 and 1986 in grazed and ungrazed areas along the Big Sioux River in eastern South Dakota. Almost half (48%) of the trees in ungrazed areas were small (diameter at breast height < 7.5 cm), but a majority (58%) of the trees in grazed areas had large diameters (diameter > 30 cm). Beaver activity was evident on 280 of 2369 (11.8%) trees (diameter > 2.5 cm) and 756 of 7794 (9.7%) stems (diameter < 2.5 cm) sampled. A greater proportion of trees were cut by beavers in ungrazed than in grazed areas. Beaver did not select tree species for cutting according to availability. Trees cut by beaver were significantly smaller in diameter than uncut trees. Mean distance from water of cut trees was less than for uncut trees. Over half (52%) of the trees damaged by beaver either resprouted or remained alive and standing. (See also W90-05491) (Author's abstract) W90-05511

RESERVOIR FISHERIES MANAGEMENT: STRATEGIES FOR THE 80'S.

For primary bibliographic entry see Field 8I. W90-05514

MANAGEMENT OF FISHERIES ON LARGE AFRICAN RESERVOIRS—AN OVERVIEW.

Food and Agriculture Organization of the United Nations, Rome (Italy). Fishery Resources and Environment Div. For primary bibliographic entry see Field 8I. W90-05516

MANAGEMENT OF THE PHYSICAL AND CHEMICAL ENVIRONMENT: EFFECTS OF WATER-LEVEL CHANGES ON RESERVOIR

ECOSYSTEMS, WITH IMPLICATIONS FOR FISHERIES MANAGEMENT.

Aquatic Ecosystem Analysts, Fayetteville, AR. For primary bibliographic entry see Field 8I. W90-05517

MODIFYING RESERVOIR FISH HABITAT WITH ARTIFICIAL STRUCTURES.

Tennessee Valley Authority, Knoxville. For primary bibliographic entry see Field 8I. W90-05518

LIMNOLOGICAL AND ECOLOGICAL CHANGES ASSOCIATED WITH RESERVOIR AGING.

Oak Ridge National Lab., TN. Environmental Sciences Div.

B. L. Kimmel, and A. W. Groeger. IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 103-109. 3 fig, 42 ref. U.S. Department of Energy contract W-7405-eng-26.

Descriptors: *Limnology, *Reservoir stages, *Reservoirs, Reservoir operation, Reservoir fisheries, Fish management, Fish, Fisheries, Water quality, Aquatic productivity, Watershed management, Management planning.

Much scientific attention has been devoted to the 'trophic upsurge and depression' observed in recently impounded reservoirs; however, little is known of the longer-term consequences of reservoir aging. Changes in the trophic status of water bodies are often a consequence of man-induced alterations of the watershed, rather than a result of the natural, gradual accumulation of nutrients and sediments. Because the formation of a man-made impoundment frequently promotes additional land-use change and technological development within the reservoir watershed, changes in water quality and biological productivity due to natural reservoir aging may be minor compared to the effects of man-induced alterations of watershed-reservoir interactions. Future trends in reservoir water quality and sport fisheries production will depend more on our ability to effectively conduct coordinated terrestrial and aquatic resources planning and management on a whole-watershed scale than on the consequences of reservoir aging per se. Coordinated research on selected impoundments and their watersheds is needed to determine the sensitivity of reservoir ecosystems to various levels of watershed perturbation, and to evaluate the effectiveness of integrated management strategies. (See also W90-05514) (Author's abstract) W90-05519

REVIEW OF WATER LEVEL MANAGEMENT ON KANSAS RESERVOIRS.

Kansas Fish and Game Commission, Emporia. For primary bibliographic entry see Field 8I. W90-05520

EFFECTS OF ENVIRONMENTAL FACTORS ON GROWTH OF LARGEMOUTH BASS IN TEXAS RESERVOIRS.

Texas Parks and Wildlife Dept., Ingram. Heart of the Hills Research Station.

L. E. Miranda, and P. P. Durocher. IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 115-121. 1 fig, 2 tab, 32 ref.

Descriptors: *Limnology, *Reservoir fisheries, *Water properties, *Chemical properties, *Physical properties, *Fish populations, *Bass, Growth, Alkalinity, Reservoirs, Water temperature, Water level fluctuations, Fish, Model studies, Environmental effects.

The effects of 13 environmental factors on growth of largemouth bass (*Micropterus salmoides*) in 55 Texas reservoirs were examined through regression analyses. Growth was measured as the average age at which largemouth bass in a population reached 254-mm total length (the statewide minimum length limit). Growth was positively correlated with log reservoir standing stock and nega-

tively correlated with elevation above mean sea level, log total alkalinity, age and average depth of reservoirs, the prey-predator ratio, and the morphoedaphic index. No significant correlations were found between growth rate and length of growing season, average water temperature in July, total dissolved solids, surface area, shoreline development, or annual water level fluctuation. The best predictive model of growth was a multiple regression that included the independent variables log reservoir age, average reservoir depth, log reservoir standing stock, and the prey-predator ratio. (See also W90-05514) (Author's abstract) W90-05521

SPATIAL HETEROGENEITY IN FISH PARAMETERS WITHIN A RESERVOIR.

Duke Power Co., Huntersville, NC. Production Environmental Services.

For primary bibliographic entry see Field 8I. W90-05522

FISHERY MANAGEMENT IN COOLING IMPOUNDMENTS.

Duke Power Co., Huntersville, NC. Production Environmental Services.

For primary bibliographic entry see Field 8I. W90-05523

OVERVIEW OF RESERVOIR FISHERIES PROBLEMS AND OPPORTUNITIES RESULTING FROM HYDROPOWER.

Sport Fishing Inst., Washington, DC.

For primary bibliographic entry see Field 8I. W90-05524

FISHERIES PROBLEMS ASSOCIATED WITH THE TRUMAN DAM PUMPED STORAGE HYDROELECTRIC PROJECT IN WEST CENTRAL MISSOURI.

Missouri Dept. of Conservation, Columbia.

For primary bibliographic entry see Field 8I. W90-05525

MANAGEMENT OF LARGEMOUTH BASS IN A PERCHED COOLING POND IN ILLINOIS.

Illinois Power Co., Clinton. Clinton Power Station.

For primary bibliographic entry see Field 8I. W90-05526

ASH BASIN EFFLUENTS AS A CONCERN OF FISHERIES MANAGERS: A CASE HISTORY AND PERSPECTIVE.

Duke Power Co., Huntersville, NC. Production Environmental Services.

For primary bibliographic entry see Field 5C. W90-05527

MANAGEMENT OF RESERVOIR RELEASES: IMPROVING THE DOWNSTREAM ENVIRONMENT BY RESERVOIR RELEASE MODIFICATIONS.

Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.

For primary bibliographic entry see Field 8I. W90-05528

LITHOLOGY, MINERALOGY, AND PALEONTOLOGY OF QUATERNARY LAKE DEPOSITS IN LONG VALLEY CALDERA, CALIFORNIA.

Geological Survey, Menlo Park, CA. Water Resources Div.

R. B. Fournier.

Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-413, 1989. 95p, 21 fig, 8 tab, 58 ref, 5 append.

Descriptors: *California, *Paleolimnology, *Lake sediments, Long Valley Caldera, Caldera lakes, Sediments, Lithology, Mineralogy, Cores, Salinity.

Field 2—WATER CYCLE

Group 2H—Lakes

Drill cores and cuttings from two drill holes, about 3 km apart, in Long Valley caldera, Mono County, California, were studied using x-ray diffraction and optical methods. A thick sequence of tuffs and lake sediments was encountered in LVCH-1 (1,000 ft deep) and Republic well 66-29 (6,920 ft deep), drilled in the southeast part of the Long Valley caldera. Ostracods, diatoms, and isotopic data indicate that the sediments and tuffs were deposited in a shallow caldera lake which changed in salinity over time. Conditions ranged from very saline in the older lake to fresh in the youngest. The sequence of secondary minerals from top to bottom is: clinoptilolite, mordenite, analcime, K-feldspar (and albite). In some geothermal systems, this sequence of secondary minerals is a function of temperature; however, the paleontological and isotopic data indicate that the change in secondary minerals with increasing depth is due to the older strata being deposited in a more saline environment. No mineralogical evidence of hydrothermal alteration is present, although the high lithium content of some clays and feldspars and the isotopic composition of some sulfate (gypsum) seems to require a hydrothermal source. (Lantz-PTT) W90-05551

ORGANIC GEOCHEMISTRY AND BRINE COMPOSITION IN GREAT SALT, MONO, AND WALKER LAKES.
Johns Hopkins Univ., Baltimore, MD. Dept. of Earth and Planetary Sciences.
For primary bibliographic entry see Field 2K.
W90-05595

SEDIMENTATION SURVEY OF LAGO DOS BOCAS, PUERTO RICO, JUNE 1985.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 2J.
W90-05618

WATER QUALITY AND RESTORATION OF THE LOWER OCONTO RIVER, OCONTO COUNTY, WISCONSIN.
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5G.
W90-05610

POPULATION DYNAMICS OF SMALL-MOUTH BASS (MICROPTERUS DOLOMIEU) IN THE GALENA (FEVER) RIVER AND ONE OF ITS TRIBUTARIES.
Wisconsin Dept. of Natural Resources, Madison.
A. M. Forbes.
Technical Bulletin No. 165, 1989. 20p, 5 fig, 13 tab, 44 ref, append.

Descriptors: *Stream fisheries, *Bass, *Galena River, *Wisconsin, *Fish populations, Pats Creek, Biomass, Fish management, Water pollution control.

The smallmouth bass fishery of the Galena (Fever) River in southwestern Wisconsin maintained a favorable reputation among anglers through the 1970s when dramatic population declines were suspected in other streams in the region. Populations were sampled in the Galena River and one of its tributaries, Pats Creek, from 1981-84. Population estimates by age group revealed interesting differences between the river and tributary populations. Although both populations were dominated by the exceptional 1980 year class in 1981 and 1982 samples, many fish from this cohort remained in the river throughout the study period, while the tributary supported few fish after 1982. This observation, coupled with data from other year classes and comparisons of habitat, temperature, and flow characteristics between the river and its tributary, suggested that Pats Creek serves as a spawning and nursery habitat and that bass move to more suitable adult habitat after age 2 or 3. However, selective mortality of these older fish cannot be eliminated as a possible factor in determining the age structure of the Pats Creek population. Population density and biomass estimates for Galena River smallmouth bass equaled or exceeded those for other stream populations in Wisconsin and adjacent

states. Other population and fishery parameters in the Galena River (growth, mortality, fishing pressure, harvest) were generally intermediate in value compared to data from other populations. Smallmouth bass growth was excellent in Pats Creek up to age 3, but was low for those few fish that remained as adults. Mortality estimates were more variable in the Pats Creek population, and fishing pressure was negligible or absent. Management recommendations resulting from this study included the following: continued, regular population assessment by personnel of the Department of Natural Resources Bureau of Fisheries Management; continued support for fish managers to purchase streamside easements and to facilitate the improvement of bank condition and riparian-zone land management; and continued or increased support for programs to reduce nonpoint source impacts on stream water quality and habitat. (Author's abstract) W90-05611

ECOLOGY OF THE LOWER COLORADO RIVER FROM DAVIS DAM TO THE MEXICO-UNITED STATES INTERNATIONAL BOUNDARY: A COMMUNITY PROFILE.
Arizona State Univ., Tempe. Center for Environmental Studies.
For primary bibliographic entry see Field 6G.
W90-05616

2I. Water In Plants

NITRIFICATION-DENITRIFICATION AT THE PLANT ROOT-SEDIMENT INTERFACE IN WETLANDS.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2H.
W90-04650

ENVIRONMENTAL FACTORS AFFECTING PHYSIOGNOMIC AND FLORISTIC VARIATION IN AN AREA OF CERRADO IN CENTRAL BRAZIL.
Escola Superior de Agricultura de Lavras (Brazil). Dept. de Ciencias Florestais.
For primary bibliographic entry see Field 2H.
W90-04725

IRRIGATION SCHEDULING MODEL WITH GROUNDWATER AND LIMITED ROOTING.
Ahmadu Bello Univ., Zaria (Nigeria). Inst. for Agricultural Research, Irrigation Research Program.
For primary bibliographic entry see Field 3F.
W90-04816

ACCURACY OF ESTIMATED REFERENCE CROP EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
For primary bibliographic entry see Field 2D.
W90-04820

SEASONAL DYNAMICS OF PRODUCTION, AND NUTRIENT ACCUMULATION AND CYCLING BY PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STUEDEL IN A NUTRIENT-ENRICHED SWAMP IN INLAND AUSTRALIA. I. WHOLE PLANTS.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
For primary bibliographic entry see Field 2H.
W90-04882

SEASONAL DYNAMICS OF PRODUCTION, AND NUTRIENT ACCUMULATION AND CYCLING BY PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STUEDEL IN A NUTRIENT-ENRICHED SWAMP IN INLAND AUSTRALIA. II. INDIVIDUAL SHOOTS.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.

For primary bibliographic entry see Field 2H.
W90-04883

VEGETATION OF THE SPECIAL ZOOLOGICAL RESERVE OF KOPACKI RIT.

Osijek Univ. (Yugoslavia).
J. Topic.
Hydrobiologia HYDRB8, Vol. 182, No. 2, p 149-160, 1989. 1 fig, 8 tab, 18 ref.

Descriptors: *Vegetation, *Flood plains, *Yugoslavia, Plant communities, Succession, Flood effects.

The results of several years' surveys on the vegetation of the Special Zoological Reserve of Kopacki Rit, Yugoslavia, are presented. Over this large floodplain of the Danube and Drava rivers different types of hygrophilic and hydrophytic communities are found. Some of them are relatively constant, having persisted in this Reserve for many years with a relatively stable distribution. Some other communities, particularly aquatic ones, appear periodically, and their area is directly influenced by surface water area and flood duration. The vegetation can be divided into 36 plant communities within the classes Lemnetae, Potamogetonetea, Littorelletea, Phragmitetea, Isoeto-Nanojuncetea, Bidentetea tripartitae, Chenopodietea, Plantaginetea majoris, Molinio-Arrhenatheretea and Quercio-Fagetetea. True succession was only observed on a few sand deposits, artificially made, where the initial stage of a willow woods is developing. The majority of old woods belonging to the association Galio-Salicetum albae are in their terminal stage. (Author's abstract) W90-04893

ROLE OF WATER RETAINING SUBSTRATA ON THE PHOTOSYNTHETIC RESPONSE OF THREE DROUGHT TOLERANT PHOTOTROPIC MICRO-ORGANISMS ISOLATED FROM A TERRESTRIAL HABITAT.
Amsterdam Univ. (Netherlands). Lab. voor Microbiologie.
For primary bibliographic entry see Field 2H.
W90-05034

INFLUENCE OF TEMPERATURE AND LIGHT INTENSITY ON ACTIVITY OF WATER HYACINTH (EICHHORNIA CRASSIPES (MART.) SOLMS).
Ljubljana Univ. (Yugoslavia). Biological Inst.
For primary bibliographic entry see Field 5D.
W90-05340

GROWTH AND DEVELOPMENT OF POTAMOGETON DISTINCTUS IN AN IRRIGATION POND IN SW JAPAN.
Oldenburg Univ. (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W90-05380

MASS MOVEMENT OF RIVER ICE CAUSES SEVERE TREE WOUNDS ALONG THE GRANDE RONDE RIVER IN NORTHEASTERN OREGON.
Forest Service, La Grande, OR. Forestry and Range Sciences Lab.
For primary bibliographic entry see Field 2C.
W90-05381

CLIMATIC AND HYDROLOGIC EFFECTS ON THE REGENERATION OF POPULUS ANGUSTIFOLIA JAMES ALONG THE ANIMAS RIVER, COLORADO.
Wisconsin Univ.-Madison. Dept. of Geography.
W. L. Baker.
Journal of Biogeography JBIODN, Vol. 17, No. 1, p 59-73, January 1990. 5 fig, 9 tab, 62 ref. NSF grant SES-8601079.

Descriptors: *Floods, *Climatic fluctuations, *Forests, *Riparian vegetation, Cottonwood trees, Population dynamics, Animas River, Colorado, Life history studies, Model studies.

Erosion and Sedimentation—Group 2J

The dates of origin of riparian forests dominated by *Populus angustifolia*, and recent interannual fluctuation in *P. angustifolia* seedling abundance on a relatively undisturbed 6-mile reach of the Animas River in southwestern Colorado, were investigated. The goal was to develop plausible hypotheses about the roles of floods and interannual climatic fluctuation in structuring these forests. The year of origin of 242 recently-established seedling and 57 forest stands was determined, and empirical models were developed relating seedling abundance and stand-origin events to climatic and hydrologic fluctuations. Seedlings were most abundant in years with cool winters, wet springs, and cool, wet falls. Both good seedling years and stand-origin years were associated with winter blocking in the North Pacific and a persistent late-summer Arizona monsoon. Extant stands originated in 10 to 13 discrete periods between 1848-1976, in years with both high spring and fall peak discharges. Expected seedling abundance and stand-origin dates since 1914 were reconstructed using climate data, and were extended to 1556 using tree-ring chronologies. Model results suggest good seedling years occurred more frequently (about every 3.4 years) than stand-origin years (about every 10-15 years). Good seedling years were 2-3 times, and stand-origin years were 5 times more common from 1848 to 1985 than from 1556 to 1848. Recent expansion of *P. angustifolia* may have been favored by more frequent cool, wet years since 1848. (Author's abstract) W90-05490

2J. Erosion and Sedimentation

ESTUARINE COHESIVE SEDIMENT SUSPENSION BEHAVIOR.

Florida Univ., Gainesville. Coastal and Oceanographic Engineering Lab.
For primary bibliographic entry see Field 2L.
W90-04561

BED LOAD TRANSPORT OF SAND MIXTURES IN ESTUARIES: A REVIEW.

Old Dominion Univ., Norfolk, VA. Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W90-04562

SEDIMENT PROCESSES IN ESTUARIES: FUTURE RESEARCH REQUIREMENTS.

Plymouth Polytechnic (England). Inst. of Marine Studies.
For primary bibliographic entry see Field 2L.
W90-04563

RESEARCH ON EROSION PROPERTIES OF COHESIVE SEDIMENTS.

Waterloopkundig Lab. te Delft (Netherlands). C. Kuiper, J. M. Cornelisse, and J. C. Winterwerp.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,341-14,350, October 15 1989. 13 fig, 4 tab, 9 ref.

Descriptors: *Channel erosion, *Scour, *Sediment transport, *Bed load, *Sediment erosion, Fluvial sediments, Erosion, Sediment distribution, Bottom sediments, Estuaries.

To describe the transport of cohesive sediments, it is necessary to specify the erosion flux at the bed. Experiments on the erosion of soft mud layers in a steady flow were performed in the Delft Tidal Flume and in an annular flume. The results were analyzed using the erosion rate function as derived by Parchure and Mehta. It is concluded that a reasonable description is possible. However, the flow erosion rate appeared to be a function of the bed shear stress. In one case, the erosion rate function needed to be adjusted slightly in order to obtain agreement between measured and calculated suspension concentrations. (Author's abstract) W90-04564

GEOMORPHOLOGIC AND SEDIMENT TRANSPORT CHARACTERISTICS OF THE

MIDDLE REACH OF THE BAHIA BLANCA ESTUARY (ARGENTINA).

Instituto Argentino de Oceanografía, Bahia Blanca.
For primary bibliographic entry see Field 2L.
W90-04565

CALIBRATION OF A GENERAL OPTICAL EQUATION FOR REMOTE SENSING OF SUSPENDED SEDIMENTS IN A MODERATELY TURBID ESTUARY.

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7C.
W90-04566

TRANSPORT PROCESSES OF SUSPENDED MATTER DERIVED FROM TIME SERIES IN A TIDAL ESTUARY.

GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). I. Grabemann, and G. Krause.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,373-14,379, October 15 1989. 9 fig, 14 ref.

Descriptors: *Sediment transport, *Suspended load, *Suspended sediments, *Estuaries, Sediment concentration, Bottom sediments, Remote sensing, Deposition, Sediment distribution, Instrumentation.

Optical beam transmittance meters integrated into Aanderaa current meters were used to measure long time series of suspended matter concentration simultaneously with current velocity and salinity in the turbidity maximum of the Weser estuary (shallow coastal plain estuary of the North Sea). They cover the spectrum from 10 min to several months. The time histories of concentrations and fluxes are shown for particular characteristic locations within the turbidity medium. The analyses demonstrate that the tidal dynamics of deposition into and resuspension of particles from temporally and spatially limited material sources at the bottom is the dominant process in the turbidity maximum while the nontidal gravitational circulation acts as a long-term source and sink. The concentration time series are useful to test mathematical models of particle dynamics in estuaries. Such models not only have to include temporary material sources at the bottom but must also provide for the effect of regular depletion and accumulation of these sources. There is remarkable repeatability of concentration patterns during similar discharge conditions. (Author's abstract) W90-04567

DATA INTERPRETATION AND NUMERICAL MODELING OF THE MUD AND SUSPENDED SEDIMENT EXPERIMENT 1985.

Hanover Univ. (Germany, F.R.). Inst. fuer Stromeungsmechanik und Elektronisches Rechnen im Bauwesen. G. Lang, R. Schumbert, M. Markofsky, H. U. Fanger, and I. Grabemann.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,381-14,393, October 15 1989. 13 fig, 1 tab, 24 ref.

Descriptors: *Sediment transport, *West Germany, *Model studies, *Mud, *Suspended load, *Suspended sediments, *Turbidity, Numerical models, Turbidity flow, Estuaries, On-site data collections, Hydrodynamics, Deposition, Instrumentation, Data interpretation.

In 1985, a field survey was performed in the Weser estuary (Northern W. Germany) covering a 30-km-long section to study the turbidity maximum in its complete extension. Moored instruments as well as shipborne vertical profilers were used in the survey. The measured data were employed in close connection with numerical simulations using a three-dimensional finite-difference model. The common aim of the investigations was to arrive at a better understanding of the hydrodynamics and the transient and spatial dynamics of the turbidity maximum in the Weser estuary. The overall behavior of the turbidity maximum resembles a cyclic

process, wherein deposition, resuspension, and advection of resuspended sediments are the dominant processes. The conceptual model, derived from the measurements, was confirmed by the numerical simulations. This is demonstrated by the calculated distribution of suspended sediment along the estuary as well as by the calculated deposition and resuspension rates at the estuarine bed for a tidal cycle. Detailed analyses of measured data (moorings) demonstrate a close relationship between the local near-bottom velocity gradient, stratification, and turbulence on one hand and the suspended sediment concentration on the other. A comparison between numerical results and measured data leads to an improved parameterization of the bottom shear stress, wherein the bottom shear stress is calculated from the near-bottom Reynolds stress, with consideration of the stratification. With this parameterization, it is shown that the model is able to reproduce some of the essential features reflected in the measured suspension sediment concentration. (Author's abstract) W90-04568

DISTRIBUTIONS OF SUSPENDED SEDIMENT AT HIGH WATER IN A MACROTIDAL ESTUARY.

Marine Biological Association of the United Kingdom, Plymouth (England). R. J. Uncles, and J. A. Stephens.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,395-14,405, October 15 1989. 10 fig, 19 ref.

Descriptors: *England, *Sediment transport, *Sediment distribution, *Estuaries, *Turbidity, *Simulation analysis, *Saline-freshwater interfaces, Neap tides, Tides, Deposition, Sedimentation, Regression analysis, Spring tides, Suspended sediments.

A turbidity maximum is consistently observed in the upper reaches of the Tamar estuary at high water. Neap tide suspended particulate matter (SPM) concentrations are typically 20 ppm at high water; spring tide concentrations are typically an order of magnitude greater. The location of the turbidity maximum is usually associated with the freshwater-saltwater interface but occasionally occurs further up-estuary. At neap tides, the maximum is less defined and can be masked by freshwater SPM concentrations. The spring tide maximum is generally small during winter periods, when it is located down-estuary, and reaches its largest concentrations during summer when it is close to the head. About 65% of the variance in the magnitude of the maximum at spring tides can be explained in terms of its distance from the head. The position of the maximum is determined mainly by freshwater runoff with a logarithmic regression explaining about 80% of the variance. Only 30-35% of the variance in the turbidity maximum magnitude and location at neap tides can be explained in terms of tidal range and runoff. A tidal resuspension model is considered that ignores density effects but that has a spatially independent, runoff dependent (but otherwise time independent) erodibility constant as a single 'free' parameter. The model provides a reasonable description of the magnitude and location of the turbidity maximum in the Tamar, both at spring and neap tides, despite the fact that the maximum usually occurs near the freshwater-saltwater interface (which in itself would strongly suggest that gravitational circulation and intratidal stability effects have a strong influence on the location of the maximum). It is possible that all three mechanisms act together to produce a much narrower maximum than has been simulated, with resuspension being enhanced in the strongly mixed freshwater behind the interface, and tidal pumping and gravitational circulation accumulating sediment close to the interface. (Author's abstract) W90-04569

SUSPENDED SEDIMENT TRANSPORT PROCESSES IN CUMBERLAND BASIN, BAY OF FUNDY.

Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). C. L. Amos, and K. T. Tee.

Field 2—WATER CYCLE

Group 2J—Erosion and Sedimentation

Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,407-14,417, October 15 1989. 14 fig, 2 tab, 26 ref.

Descriptors: *Sediment transport, *Suspended sediments, *Canada, *Suspended load, *Bay of Fundy, Sediment concentration, Sediment distribution, Deposition, Bed load, Bays, Tidal flats, Model studies.

Cumberland Basin, located at the head of Chignecto Bay, Bay of Fundy, exhibits a seaward (exponential) decreasing, time-dependent, surface sediment concentration. There is a strong correlation between suspended sediment concentrations and longitudinal concentration gradient. A similar correlation was found in Shepody Bay, Chignecto Bay, and Minas Basin, suggesting that an equilibrium condition exists between the two variables. Total suspended mass in Cumberland Basin was constant over 2 years of observation (10 to the 11th power g) despite changes in sediment concentration and concentration gradient. Temporal controls on suspended sediment concentration are river influx, ice melting, dispersion, settling on the intertidal mud flats, and water mass exchange at the mouth of the basin. This exchange is due to cross-channel velocity variations; exchanges due to tidal current asymmetry and settling lag are small. A simple box model was developed to study the temporal variation of total suspended sediment in the basin. The results show that the water mass exchange at the basin mouth varies with time and is the dominant factor controlling suspended mass due to efficient dampening of temporal fluctuations in suspended mass. (Author's abstract)

W90-04570

OBSERVATIONS AND MODEL OF SEDIMENT TRANSPORT NEAR THE TURBIDITY MAXIMUM OF THE UPPER SAINT LAWRENCE ESTUARY.

National Water Research Inst., Burlington (Ontario). Lakes Research Branch. P. F. Hamblin.

Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,419-14,428, October 15 1989. 11 fig, 22 ref.

Descriptors: *St Lawrence Estuary, *Sediment transport, *Suspended sediments, *Estuaries, *Tidal currents, *Sediment distribution, Tides, Suspended load, Deposition, Model studies, Turbidity.

The need to investigate the role of suspended sediments in the transport and fate of chemical contaminants in the St. Lawrence estuary has led to the measurement of profiles of suspended sediments, horizontal current, temperature, and salinity at an anchor station approximately 60 km downstream from the turbidity maximum. Hourly profiles over nearly three semidiurnal tidal cycles reveal peaks of suspended sediment concentration following maximum flood and ebb currents at the bottom, whereas near the surface there is only one maximum in suspended sediment concentrations per tidal cycle. Observations of the distributions of suspended sediment and its horizontal flux suggest that local resuspension is the controlling factor at the measurement site. It is demonstrated that landward sediment flux in the lower layer is maintained by the ebb-flood asymmetry mechanism described by Dronkers and by the asymmetry in vertical mixing due to fluctuations in stratification related to the intrusion of the salt wedge. The latter mechanism is explored in detail by means of a vertical transport model for fine-grained newly deposited sediments. The model employing standard prescriptions for mixing and resuspension results in the best match between simulated and observed sediment distributions for a particle sinking velocity of 0.0003 m/s. This settling rate corresponds to a mean particle size of 15 microns, which compares closely with the average earlier observed particle size of 10 to 20 microns. (Author's abstract)

W90-04571

MODELING THE EFFECT OF SUSPENDED SEDIMENT STRATIFICATION ON BOTTOM EXCHANGE PROCESSES.

Florida Univ., Gainesville. Coastal and Oceanographic Engineering Lab.

Y. P. Sheng, and C. Villaret.

Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,429-14,444, October 15 1989. 24 fig, 41 ref.

Descriptors: *Model studies, *Suspended sediments, *Sediment transport, *Bottom sediments, *Sediment concentration, Estuaries, Sedimentation, Deposition, Sediment erosion, Density stratification.

A vertical gradient of suspended sediment concentration often exists in estuaries, particularly within the bottom boundary layer, where sediment erosion and deposition take place. This results in a vertical density gradient and hence, modification of the flow. However, this important effect has often been ignored in past sediment studies. Because of this and because of other empirical assumptions, existing erosion models cannot be used as predictive tools. A simplified second-order closure model is presented that simulates the effect of sediment-induced stratification on bottom boundary layer dynamics, and particularly the erosion process. Numerical models, which employ the concept of Richardson number dependent eddy viscosity, have been developed in the past for stratified flows. These models require a large number of data for tuning parameters of the eddy viscosity formula. The simplified second-order closure model used consists of the dynamic equations of motion for mean variables (velocity, temperature, salinity, density, and suspended sediment concentration) and turbulent quantities of turbulent kinetic energy and turbulence macroscale. Model constants are thus invariant, owing to the added physics. Model simulations of laboratory sediment-laden boundary layers indicate that, as sediments are eroded or resuspended from the bottom, a vertical gradient of suspended sediment concentration can lead to a significant reduction of the turbulent shear stresses and a slowdown of the erosion-resuspension process. Hence, significant error may be contained in some empirical sediment erosion rate formulas, which were derived by ignoring flow-sediment interactions. Simulations of a wave boundary layer and a thermally stratified boundary layer, obtained with the same numerical model, are also presented. There is good agreement between measured and simulated mean and turbulent quantities in both cases. (Author's abstract)

W90-04572

BEDFORMS, BED MATERIAL, AND BED-LOAD TRANSPORT IN A SALT-WEDGE ESTUARY: FRASER RIVER, BRITISH COLUMBIA.

Guelph Univ. (Ontario). Dept. of Geography. R. A. Kostachuk, M. A. Church, and J. L. Luternauer.

Canadian Journal of the Earth Sciences CJESAP, Vol. 26, No. 7, p 1440-1452, 1989. 11 fig, 2 tab, 8 ref.

Descriptors: *Channel erosion, *Salt flats, *Estuaries, *Saline-freshwater interfaces, *Sediment transport, *Bottom sediments, *Bed-load discharge, Bed load, Sediment load, Stream discharge, Fraser River, Canada.

The lower main channel of the Fraser River, British Columbia, is a sand-bed, salt-wedge estuary in which variations in velocity, discharge, and bedform characteristics are controlled by river discharge and the tides. Bed-material composition remains consistent over the discharge season and in the long term. Changes in bedform height and length follow but lag behind seasonal fluctuations in river discharge. Migration rates of bedforms respond more directly to river discharge and tidal fall than do height and length. Bedform characteristics were utilized to estimate bedload transport in the estuary, and a strong, direct, but very sensitive relationship was found between bed load and river discharge. Annual bedload transport in the estuary is estimated to be of the order of 0.35 Mt in 1986. Bedload transport in the estuary appears to be higher than in reaches upstream, possibly because of an increase in sediment movement along the bed to compensate for a reduction in suspended bed-material load produced by tidal slack water and the salt wedge. (Author's abstract)

W90-04586

ON-OFFSHORE BEDLOAD SEDIMENT TRANSPORT IN THE COASTAL ZONE.

Polish Academy of Sciences, Gdansk. Inst. Budownictwa Wodnego. Z. Pruszek.

Coastal Engineering COENDE, Vol. 13, No. 3, p 273-292, September 1989. 10 fig, 1 tab, 28 ref.

Descriptors: *Sediment transport, *Bed load, *Sediment distribution, *Marine sediments, *Bottom sediments, Coastal waters, Bottom currents, Sedimentation, Onshore currents, Offshore currents.

Laboratory data and theoretical derivations are presented for cross-shore bedload transport. The laboratory investigations were carried out in a wave flume with movable bed (sand with D50 = 0.022 cm). The test have shown, inter alia, that bedload transport in the surf zone is shoreward if single breaking occurs (i.e., on a uniform slope or at a single bar) and is accompanied by offshore transport seaward of the breaking point. Multiple transitions from offshore to onshore transport take place if the wave-breaking process repeats (on beds with more than one bar). The theoretical considerations are based on Bagnold's energetics approach. The sediment transport is assumed by be controlled primarily by asymmetric oscillatory motion of water superimposed on a steady return current, gravity, and the critical conditions of incipient sediment movement. The parameters intervening in the theoretical formulas have been identified. Good agreement between theory and experiments has been reached, in particular for short waves and beds with no more than one underwater bar. The formulas derived have been found to be acceptable for Ursell numbers $S < 60$. (Author's abstract)

W90-04588

DEPOSITIONAL MODEL OF A MACROTIDAL ESTUARY AND FLOODPLAIN, SOUTH ALLIGATOR RIVER, NORTHERN AUSTRALIA.

Australian National Univ., Canberra. North Australia Research Unit.

C. D. Woodroffe, J. Chappell, B. G. Thom, and E. Wallensky.

Sedimentology SEDIAT, Vol. 36, No. 5, p 737-756, October 1989. 11 fig, 2 tab, 31 ref.

Descriptors: *Estuaries, *Tidal flats, *Sediment transport, *Sediment distribution, *Sinuous flow, *Geomorphology, Deposition, Stratification, Meanders, Flood plains, Paleohydrology, South Alligator River, Australia.

The South Alligator River, Northern Territory of Australia, has a macrotidal estuary. Tidal influence extends 105 km up the channel. It is dominated by freshwater in the wet season (Dec.-April) with a salt wedge near the mouth, but is well-mixed and becomes saline throughout the dry season. The tidal channel can be divided into four different channel types: an estuarine funnel, a sinuous meandering segment, a cusped meandering segment, and an upstream tidal channel. The distribution of morphologically defined land classes and morphological units within each land class on the floodplain flanking the estuary differs from one channel type to another. Several stratigraphic and morphostratigraphic units have been recognized from drill holes on the coastal and deltaic-estuarine plains, and a model of development is proposed on the basis of extensive radiocarbon chronology and palynology. In the sinuous segment of the estuary, the channel has migrated laterally across the floodplain. Previous channel positions are indicated by paleochannels and the meander tract is occupied by laminated channel sediments. Within the cusped segment, there are numerous sinuous paleochannels on the plains. In the upstream segment, the channel and paleochannels have long straight reaches with irregular bends and discontinuous levees, and channel avulsion is indicated. Mangrove mud is a widespread stratigraphic unit throughout the plains. The mangrove forests disappeared from most of the plains as vertical accretion

continued, and were replaced by grass and sedge-covered floodplains. During the sinuous phase about 5300-2500 yr BP, the channel migrated laterally and eroded the deltaic-estuarine plain and deposited lateral accretion deposits (laminated channel sediments). Transgressive and big swamp phases occurred under rising and stabilizing sea level, respectively. Later morphodynamic channel adjustments occurred under conditions of stable sea level. (Author's abstract)
W90-04613

SAND DETACHMENT BY SINGLE RAINDROPS OF VARYING KINETIC ENERGY AND MOMENTUM.

North Dakota State Univ., Mandan. Land Reclamation Research Center.
P. P. Sharma, and S. C. Gupta.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1005-1010, July/August 1989. 4 fig, 2 tab, 20 ref. USDA-ARS agreement 58-3264-6-107.

Descriptors: *Erosion, *Soil erosion, *Rainfall impact, *Soil strength, *Soil stability, *Sand, Rainfall, Kinetic energy, Soil physical properties, Laboratory methods.

Soil detachment by raindrops is a precursor to the start of interrill erosion and surface seal formation. Soil detachment occurs when erosive forces of raindrops are greater than the inherent strength of soil. Experiments were conducted to study the importance of inherent soil strength on detachment of soil by raindrops. Sand strength was controlled by varying matric potentials before raindrop impact. A range of raindrop kinetic energies and momentum was created by changing drop diameter (3.6-5.0 mm) and fall height (1-8 m). The experimental setup consisted of a varying height water drop former, an electronic drop discriminator, and a single-drop splash collector. Splash collected by varying drop height of a 4.6-mm-dia. drop on sand equilibrated at a matric potential of minus 1.5 kPa (higher strength) showed that a larger threshold energy is needed to initiate soil detachment than when equilibrated at minus 0.1 kPa (lower strength). Also, the threshold erosivity was larger in magnitude and more significant when using momentum as an index of erosivity instead of kinetic energy. The relationships between sand splash and erosivity were linear ($p < 0.001$) for raindrops with diameters of 3.6 to 5 mm falling from heights of 0.76 to 7.6 m on sand equilibrated at minus 1.0 kPa. Sand splash was represented by a model that included detachment, raindrop erosivity, threshold erosivity, sand detachability, and an exponent equal to 1. This equation for describing soil detachment as a function of erosivity is an improvement over the currently used nonlinear relationship. (Author's abstract)
W90-04616

SLOPE AND PHOSPHOGYPSUM'S EFFECTS ON RUNOFF AND EROSION.

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
D. Warrington, I. Shainberg, M. Agassi, and J. Morin.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1201-1205, July/August 1989. 4 fig, 14 ref.

Descriptors: *Erosion control, *Soil erosion, *Loam, *Runoff, *Slopes, *Soil stability, *Infiltration rate, *Rainfall infiltration, Infiltration, Soil water, Rainfall-runoff relationships, Rainfall simulators, Rainfall impact.

The effect of slope on runoff and erosion has been studied mainly in stable soils. Loamy soils from semiarid regions have unstable structures and tend to seal during a rainstorm. The permeability of the seal is sensitive to water quality. The effect of slope angle (5-30%) and addition of phosphogypsum (PG), which changes the water quality, on the infiltration rate (IR), runoff and erosion from an unstable sandy loam soil material (Typic Rhodoxeralf) was studied using a rain simulator. Increasing the slope slightly reduced the amount of runoff and increased the final infiltration rate. The increase in

final IR was due to seal erosion. The PG application increased the permeability of the seal, tripled the final IR of the soil sample and decreased the volume of runoff by 50%. Phosphogypsum application also reduced erosion by 60% at the gentlest slope angle. Change in slope angle from 5 to 25% doubled soil loss in the PG-treated soil samples but increased by seven-fold soil loss from the untreated soil samples. Gypsum treatment releases electrolytes into the percolating and runoff water. Its effect on soil erosion is due to decreasing the fraction of runoff water, stabilizing the soil structure at the soil surface, and increasing the rate of sediment deposition. The dramatic effect of PG in reducing erosion from steep slopes may be used in stabilizing soil structures on steep slopes. (Author's abstract)
W90-04626

SOIL NITROGEN CHANGES DURING PRIMARY SUCCESSION ON A FLOODPLAIN IN ALASKA, U.S.A.

Alaska Univ., Fairbanks. Arctic Environmental Engineering Lab.
For primary bibliographic entry see Field 2G.
W90-04639

STREAM DEVELOPMENT IN GLACIER BAY NATIONAL PARK, ALASKA, U.S.A.

Forest Service, Logan, UT. Intermountain Research Station.
R. C. Sidle, and A. M. Milner.
Arctic and Alpine Research ATLPV, Vol. 21, No. 4, p 350-363, November 1989. 12 fig, 2 tab, 37 ref.

Descriptors: *Geomorphology, *Glacial streams, *Arctic, *Suspended sediments, *Sediment transport, *Riparian vegetation, *Vegetation establishment, Aquatic habitats, Glacier Bay National Park, Alaska, Streams, Channel morphology, Thalweg, Flood plains, Stream banks.

The effects of hydraulics, sediment supply, channel condition, and riparian vegetation on stream development were examined in a chronosequence of 5 streams in Glacier Bay National Park where rapid retreat of glacial ice has exposed landscapes of different ages within a confined region. The youngest stream, Wolf Point creek (deglaciated around 1955), is fed by a remnant glacier and had the highest suspended sediment concentrations of all streams (103-111 mg/l at baseflows). The main channel of Wolf Point creek was relatively wide and stable because of the peak flow buffering effects of the remnant glacier and associated lake. However, the floodplain was periodically inundated and only sparsely vegetated and highly braided. The study reach at Nunatak Creek (deglaciated around 1950) was actively downcutting through fine glacial outwash deposits creating a deeper thalweg and redepositing some material near channel margins. About 100 yr after deglaciation (Ice Valley stream), woody riparian vegetation begins to stabilize streambanks and becomes established on gravel bars where it provides potential sites for incipient woody debris dams. The Ice Valley channel shows only minimal degradation. The increased accumulation of woody material and the subsequent colonization of gravel bars by alder and willow have begun to increase channel and bank stability and pool formation in Berg Bay South (deglaciated around 1830). Berg Bay South appears to be near equilibrium with respect to sediment supply and transport. Berg Bay North, a stream of similar age to Berg Bay South, stabilized more rapidly because of the buffered peak flows and greater sediment trapping efficiency attributed to the lakes and bogs in the north stream system. Fish habitat improves as postglacial streams develop: pools begin to form, riparian cover increases, and sediment transport decreases. (Author's abstract)
W90-04640

RUNOFF AND FLOCCULATION MODIFY UNDERWATER LIGHT ENVIRONMENT OF THE HUDSON RIVER ESTUARY.

State Univ. of New York at Albany. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2L.

W90-04642

PARTICLE-BORNE RADIONUCLIDES AS TRACERS FOR SEDIMENT IN THE SUSQUEHANNA RIVER AND CHESAPEAKE BAY.

Florida State Univ., Tallahassee. Dept. of Geology.
J. F. Donoghue, O. P. Bricker, and C. R. Olsen.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 4, p 341-360, October 1989. 3 fig, 7 tab, 28 ref, append. Department of Energy, contract DE-AC05-84OR21400.

Descriptors: *Rivers, *Chesapeake Bay, *Estuaries, *Sediment transport, *Radioactive tracers, Nuclear powerplants, Dams, Reservoirs, Susquehanna River, Sedimentation rates, Turbidity, Sediment yield, Trap efficiency.

The Chesapeake Bay receives nearly one million tonnes of sediment annually from its major tributary, the Susquehanna River. The pattern of deposition of this sediment affects the lifetime of the estuarine resource and the fate of any sediment-borne contaminants. Previous estimates of the extent to which Susquehanna River sediment is transported down the Chesapeake have differed considerably. By use of reactor-generated radionuclides adsorbed on the river sediment, a sediment budget has been compiled for the upper Chesapeake Bay and the reservoirs on the lower Susquehanna. Reservoirs impound nearly 1.4 million tonnes of sediment annually behind the power dams on the lower Susquehanna River. Without the dams, sediment delivery to the upper bay would more than double. The uppermost Chesapeake Bay, within and above the turbidity maximum, retains virtually all of the fluvial sediment delivered to it. The result is an annual sedimentation rate of approximately 3 mm/yr in the upper bay, an infilling rate that is nearly equal to the regional rate of sea level rise. (Author's abstract)
W90-04645

COMPARISON OF EXTRACTION METHODS FOR POLYCYCLIC AROMATIC HYDROCARBON DETERMINATION IN SEDIMENTS.

Brno Univ. (Czechoslovakia). Dept. of Environmental Studies.
For primary bibliographic entry see Field 5A.
W90-04707

SUSPENDED MATTER IN THE SOUTH YELLOW SEA.

Woods Hole Oceanographic Institution, MA.
Y. Qin, F. Li, S. Xu, J. Milliman, and R. Limeburner.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 2, p 101-112, 1989. 12 fig, 1 tab, 13 ref.

Descriptors: *Suspended sediments, *Sediment distribution, *Coastal waters, *China, Sediment discharge, Stratification, Wave action, Continental shelf.

Suspended matter in sea water has been investigated in the South Yellow Sea during 1983-1984. The results show that horizontal distribution of suspended matter might be divided into five regions: The region off Northern Jiangsu coast, characterized by highest concentration of more than 200 mg/L in surface water; the region off the estuary of the Changjiang River and off the Chengshanjiao Cap with a high concentration of suspended matter; the region of the central part of the South Yellow Sea and off the Haizhou Bay with a low concentration; the region around the Chengshanjiao Cap with turbid water carrying sediment from the Huanghe River stretching westward and exerting influence on the northwest part of this area; a tongue shaped region with a higher concentration of 20 mg/L extending to the northeast and exerting influence on the south part of the investigated area. The central region of the South Yellow Sea is not immediately affected by present sediments discharged from the Huanghe and Changjiang Rivers. The suspended matter is clearly stratified. It is interesting to note that there is a layer around

Field 2—WATER CYCLE

Group 2J—Erosion and Sedimentation

which the concentration gradient of suspended matter is steeper. It looks similar to a pycnocline or thermocline, so it might be called 'suspended-cline'. It is located below the pycnocline and perhaps affects some important properties of sea water by mixing liquid with various suspended matter. Most of the suspended matter is resuspended from the sea floor; the sediments are from rivers and biogenic matter. The concentration and components of the suspended matter are different from those in the semi-closed Bohai Sea and those over the outer continental shelf in the East China Sea. The main factor influencing the concentration distribution of suspended matter is waves. Sediment loads from the rivers only affect the estuary and nearshore areas. Tidal current strengthens the action of waves on sediment on the sea floor. Cold water masses in the central region of the South Yellow Sea also exert influence on the horizontal and vertical dispersion of suspended matter. (Author's abstract)
W90-04720

CARBONATE SEDIMENTS IN LAKES OF YUNNAN, CHINA.

For primary bibliographic entry see Field 2H.
W90-04721

SEDIMENTATION RATES OF PARTICULATE ORGANIC DETRITAL CARBON, NITROGEN AND PHOSPHORUS IN DONGHU LAKE, WUHAN.

W. Lin, and X. Liu.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 2, p 163-170, 1989. 2 fig, 7 tab, 9 ref.

Descriptors: *Sedimentation rates, *Particulate matter, *Nutrients, *Lakes, Carbon, Nitrogen, Phosphorus, China.

An investigation for measuring the sedimentation rates of particulate organic detrital (POD) carbon, nitrogen, and phosphorus, was carried out in the Donghu Lake, Wuhan, China, from January 1983 to November 1984. During this two-year period, the contents of carbon, nitrogen, phosphorus and chlorophyll a in the settled organic matter were investigated, and the ratios of dry wt./wet wt., C/N and C/P of the dominant plankters were measured. The sedimentation rate of POD in terms of carbon, nitrogen and phosphorus were calculated. The sedimentation rates of POD (g/sq m/yr) of the Lake, 1983-1984, Station I, were 10.67 and 10.97 (C), 2.15 and 2.68 (N), 0.29 and 0.30 (P); Station II, are 10.35 and 7.26 (C), 2.17 and 1.12 (N), 0.22 and 0.16 (P), respectively in sequence of the years. Compared to the net phytoplankton production carbon, the particulate organic detrital carbon accounted for only a small percentage: they were 1.96% and 2.39% (Station I), and 1.36% and 0.93% (Station II). (Author's abstract)
W90-04723

RIVER-CHANNEL CHANGES IN ENGLAND AND WALES.

Portsmouth Polytechnic (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-04903

NEW TECHNIQUE FOR MEASURING FINE SEDIMENT IN STREAMS.

Wyoming Univ., Laramie. Water Resources Research Inst.
For primary bibliographic entry see Field 7B.
W90-04919

LAKE PATZCUARO, MEXICO: RESULTS OF A NEW MORPHOMETRIC STUDY AND ITS IMPLICATIONS FOR PRODUCTIVITY ASSESSMENTS.

Universidad Michoacana de San Nicolas de Hidalgo, Morelia (Mexico). Lab. de Biología Acuática.
For primary bibliographic entry see Field 2H.
W90-04961

SEDIMENTARY ENVIRONMENTS INFERRED FROM LITHOFACIES OF THE LAKE BIWA 1400 M CORE SAMPLE, JAPAN, (IN JAPANESE).

Kyoto Univ., Beppu (Japan). Geophysical Research Station.
K. Takemura, and T. Yokoyama.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p 247-254, 1989. 4 fig, 2 tab, 13 ref. English summary.

Descriptors: *Paleolimnology, *Limnology, *Sedimentology, *Cores, *Lake sediments, *Japan, *Lake Biwa, Geology, Sand, Silt, Shales, Gravel, Deposition.

The analysis of a 1,422.5 m core sample from Lake Biwa revealed the sequence and environment of the deposition. The basement rock at the depth of 911.4 m consists of alternations of sandstone and shale. The lake sediments on the bedrock are divided into five units (P,Q,R,S and T Beds in ascending order) from the sedimentological and lithological viewpoints. These units include 54 volcanic ash layers. The P Bed, consisting of poorly sorted cobble to pebble gravels, is considered the land area deposition. The Q bed, composed of cobble to pebble gravels and of alternations of sand and silt, is considered to have been formed in a fluvial environment. The R Bed, composed of the alternations of two subunits (1: massive clay, 2: alternations of sand, silt and gravel), may be lacustrine in origin from deposits in shallow water near the shore. The S Bed consists of alternations of sand and silt layers with thin gravel layers, and this bed is considered to have been deposited in a fluvial environment. The T Bed, composed of massive and homogeneous clay, is considered to have been deposited in standing water such as the present Lake Biwa. The distribution of reflection surfaces obtained by the air-gun survey indicates that the boundaries of the sedimentary units extend horizontally to a wide area. (Author's abstract)
W90-05057

HEAVY-METAL GEOCHEMISTRY OF SEDIMENTS IN THE PUEBLO RESERVOIR, COLORADO.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05068

CHARACTERIZATION OF COLLOIDS IN THE MISSISSIPPI RIVER AND ITS MAJOR TRIBUTARIES.

Geological Survey, Denver, CO.
T. F. Rees, and J. F. Ranville.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p513-522, 5 fig, 3 tab, 6 ref.

Descriptors: *Mississippi River, *Colloids, Particle size, Distribution, Velocity, Correlation analysis, Clays, Quartz, Rutile, Organic matter.

Colloids collected from the Mississippi River and its major tributaries during sampling cruises during the summer and winter of 1987 have been characterized as to colloid concentration, particle-size distribution, mineralogy, and electrophoretic mobility. Colloid concentrations generally correlated with main stream velocity. Particle-size distributions were generally unimodal, with larger particles in the Mississippi main stem than in the tributaries. Mineralogy of the colloids was dominated by clays, with lesser amounts of quartz, rutile, and organic material. Electrophoretic mobilities ranged from -1.27 to -2.88 x 10 to the -8th sq m/sec/volt, and were generally more negative in the summer than in the winter. (See also W90-05059) (Author's abstract)
W90-05115

ESTIMATES OF MONTHLY STREAMFLOW CHARACTERISTICS AT SELECTED SITES IN THE UPPER MISSOURI RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1937-86.

Geological Survey, Helena, MT. Water Resources

Div.

For primary bibliographic entry see Field 2E.
W90-05205

STREAMFLOW, SEDIMENT DISCHARGE, AND STREAMBANK EROSION IN CACHE CREEK, YOLO COUNTY, CALIFORNIA, 1953-86.

Geological Survey, Sacramento, CA. Water Resources Div.
J. G. Harmon.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4188, May 1989. 40p, 10 fig, 10 tab, 16 ref.

Descriptors: *Channel morphology, *Bank erosion, *Erosion, *California, *Land use, *Sediment discharge, Capay Valley, Cross-sections, Sinuosity, Stream banks, Slopes, Yolo County.

This report defines cross-section geometry, slope, sinuosity, bed and bank material size, and sediment discharge for Cache Creek, Capay Valley, Yolo County, California; it also relates streambank erosion to daily volumes of flow greater than 6,000 acre-ft. Mean bed elevations at six cross sections during 1983-86 and at two cross sections over several years indicate general stability of elevations in the gravel-bed channel. Water-surface slope ranged from 0.13% to 0.51% in four reaches during two flood peaks. Aerial photographs indicate that the Cache Creek channel is sinuous. About 67% of bed material at 45 cross sections is gravel, and 23% is coarser than gravel. Bank material at 27 cross sections contain sands, silt, and clay, except at one cross section where cobbles and gravel form the left bank. The sediment-discharge rate was lower during 1984-86 than in 1960-63. Streambank erosion was measured by comparing aerial photographs taken over several years. Eroded areas total about 13.2 million sq ft (300 acres) from 1953 to 1984. Net migration is toward the right bank. (USGS)
W90-05210

MINERALOGY AND GRAIN SIZE OF SURFICIAL SEDIMENT FROM THE BIG LOST RIVER DRAINAGE AND VICINITY, WITH CHEMICAL AND PHYSICAL CHARACTERISTICS OF GEOLOGIC MATERIAL FROM SELECTED SITES AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.
R. C. Bartholomay, L. L. Knobel, and L. C. Davis.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-384, July 1989. 74p, 14 fig, 23 tab, 35 ref.

Descriptors: *Sediments, *Data collections, *Mineralogy, *Particle size, *Fluvial sediments, Idaho, X-ray diffraction.

The U.S. Geological Survey's Idaho National Engineering Laboratory project office, in cooperation with the U.S. Department of Energy, collected 35 samples of surficial sediments from the Big Lost River drainage and vicinity from July 1987 through August 1988 for analysis of grain-size distribution, bulk mineralogy, and clay mineralogy. Samples were collected from 11 sites in the channel and 5 sites in overbank deposits of the Big Lost River, 6 sites in the spreading areas that receive excess flow from the Big Lost River during peak flow conditions, 7 sites in the natural sinks and plays of the Big Lost River, 1 site in the Little Lost River Sink, and 5 sites from other small, isolated closed basins. Eleven samples from the Big Lost River channel deposits had a mean of 1.9 and median of 0.8 weight percent in the less than 0.062 mm fraction. The other 24 samples had a mean of 63.3 and median of 63.7 weight percent for the same size fraction. Mineralogy data are consistent with grain-size data. The Big Lost River channel deposits had mean and median percent mineral abundances of total clays and detrital mica of 10 and 10%, respectively, whereas the remaining 24

Erosion and Sedimentation—Group 2J

samples had mean and median values of 24% and 22.5%, respectively. (USGS)
W90-05271

MINERALOGY AND GRAIN SIZE OF SURFICIAL SEDIMENT FROM THE LITTLE LOST RIVER AND BIRCH CREEK DRAINAGES, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.
R. C. Bartholomay, and L. R. Knobel.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-385, July 1989. 19p, 3 fig, 6 tab, 13 ref.

Descriptors: *Data collections, *Sediments, *Fluvial sediments, *Mineralogy, *Particle size, *Idaho, X-ray diffraction.

The U.S. Geological Survey's Idaho National Engineering Laboratory project office, in cooperation with the U.S. Department of Energy, collected 13 samples of surficial sediments from the Little Lost River and Birch Creek drainages during August 1988 for analysis of grain-size distribution, bulk mineralogy, and clay mineralogy. Samples were collected from five sites in the channel of the Little Lost River, two sites from overbank deposits of the Little Lost River, five sites in the channel of Birch Creek, and one site from an overbank deposit of Birch Creek. Six samples from the Birch Creek channel and overbank deposits had a mean of 7.9 and median of 2.5 weight percent in the less than 0.062 mm fraction. The seven samples from the Little Lost River channel and overbank deposits had a mean of 34.5 and median of 23.8 weight percent for the same size fraction. Mineralogy data indicated that Birch Creek had larger mean percentages of quartz and calcite, and smaller mean percentages of total feldspar and dolomite than the Little Lost River deposits. Illite was the dominant clay mineral present in both drainages, but the Little Lost River deposits contained more smectite, mixed-layer clays, and kaolinite than the Birch Creek deposits. (USGS)
W90-05273

SEDIMENTATION OF LAKE TANEYCOMO, MISSOURI, 1913-1987.

Geological Survey, Rolla, MO. Water Resources Div.
W. R. Berkas.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4160, 1990. 80p, 41 fig, 27 tab, 12 ref.

Descriptors: *Sedimentation, *Sedimentation rates, *Isotope studies, *Lake sedimentation, *Siltation, *Reservoir siltation, Particle size, Surface water, Missouri.

On the basis of the data from a sedimentation survey done by the U.S. Department of Agriculture, Soil Conservation Service, during 1935 and data collected by the U.S. Geological Survey during 1987, the volume of sediment accumulated in Lake Taneycomo from 1913 to 1935 and 1913 to 1987 was determined. Table Rock Dam, built directly upstream from Lake Taneycomo during 1958, eliminated about 92% of the 4,644-sq mi basin from contributing sediment directly to the lake. Cesium-137 isotope was used as a tracer in the sediment to determine the quantity of deposition in the lake after Table Rock Dam was completed. The relation between cross-sectional area and distance upstream from the dam (curve method) was used to determine the 1913 (original), the 1935, and the 1987 volumes of Lake Taneycomo. A total of 910,000,000 cu ft of sediment accumulated between 1913 and 1935, 42% of the original volume of the lake. A total of 1,066,000,000 cu ft of sediment accumulated between 1913 and 1987, 49% of the original volume. Lake Taneycomo seems to be functioning as an alluvial river, responding to the new energy gradient established by the spillway at Ozark Beach Dam, and later to changes in the sediment load. The upper two-thirds of the lake seems to have

been scoured after Table Rock Dam greatly decreased the sediment load to the lake. The cesium-137 analysis indicated that sediment is still accumulating in the lower reaches of the lake, with measured accumulation generally ranging from 0.2 to 2.6 ft. (USGS)
W90-05284

ECONOMIC RESERVOIR DESIGN AND STORAGE CONSERVATION BY REDUCED SEDIMENTATION.

Illinois State Water Survey Div., Champaign.
K. P. Singh, and A. Durgunoglu.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 85-97, January/February 1990. 5 fig, 4 tab, 14 ref, 2 append.

Descriptors: *Reservoir design, *Reservoir siltation, *Sedimentation, Mathematical models, Reservoir storage, Economic aspects, Reservoir operation, Illinois.

A mathematical model has been developed for estimating the design storage capacity of a reservoir by using the expected water demand, storage loss due to sedimentation, and physical and hydrological characteristics of the watershed. Suitable mitigative measures can be incorporated in dam design and reservoir operation to substantially reduce sediment entrapment in the reservoir, and to improve dissolved oxygen levels by releasing hypolimnetic waters from the reservoir. These measures may also greatly reduce streambed degradation downstream of the dam and consequent initiation of a new erosion cycle in the tributaries. Reservoir design based on storage conservation is of prime importance considering the dearth of new feasible sites for reservoirs. Economic analyses for different storage-maintenance measures (such as undersluices and flushing pipes) have been investigated in terms of reduction in initial reservoir design storage, cost of installing measures, and cost of any dredging operations. These analyses are performed for a site in Illinois for several water-demand levels and useful lives of the reservoir. The results of the model application indicate that sedimentation reduction can be economically achieved in the design of new dams and reservoirs as well as in retrofitting existing ones. (Author's abstract)
W90-05304

NEW REVETMENT DESIGN CONTROLS STREAMBANK EROSION.

Forest Service, Albuquerque, NM. Southwestern Region.
For primary bibliographic entry see Field 4D.
W90-05331

NEW METHOD OF STREAM BANK PROTECTION.

Saint Charles City Engineer's Office, MO.
For primary bibliographic entry see Field 4D.
W90-05332

FILL SLOPE REPAIR USING SOIL BIOENGINEERING SYSTEMS.

Sotir (Robbin B.) and Associates, Marietta, GA.
For primary bibliographic entry see Field 8D.
W90-05333

EMERGENCY WATERSHED PROTECTION USING STRAW BALES.

Miles (Thomas R.), Portland, OR.
For primary bibliographic entry see Field 4D.
W90-05334

RATES AND PATTERNS OF ESTUARINE SEDIMENT ACCUMULATION.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 2L.
W90-05393

SESTON VERTICAL FLUX MODEL FOR EUTROPHIC RESERVOIR.

Malaga Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 2H.
W90-05452

VARIATIONS IN RESERVOIR SEDIMENTATION IN SCOTLAND IN RESPONSE TO LAND USE CHANGES.

Saint Andrews Univ. (Scotland). Dept. of Geography.
R. W. Duck, and J. McManus.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p. 19-26, November 1989. 3 fig, 1 tab, 13 ref.

Descriptors: *Siltation, *Reservoir sediments, *Reservoirs, *Sedimentation, *Land use, *Erosion, *Reforestation, *Agriculture, Runoff, Farming, Scotland.

In addition to the many major lakes which characterize the landscape of Scotland innumerable small artificial reservoirs have been created during the last 150 years. With changes in legislation controlling inspection and maintenance of the impounding embankments and valve gear, many of these water bodies have been drawn-down over the past 5 years. The unrivalled opportunity to examine reservoir floor sediments readily has permitted deposit thicknesses and the physical characteristics of the materials to be investigated. Cores from the reservoir beds show systematic variations of grain size (expressed as median grain size, percentage of sand, etc.) in many cases. Analysis of well documented agricultural records reveals progressive changes in land use which were interrupted by increased cultivation of marginal lands in response to the national emergency of World War II. Subsequent evolution of farming activity is also reflected in the upper segments of the cores. Increased recent afforestation, preceded by deep ploughing for drainage, permits increased runoff and sediment erosion, with consequential increased sedimentation in downstream reservoirs. Some have become totally infilled with sediment at this stage. (Author's abstract)
W90-05453

SEDIMENTATION SURVEY OF LAGO LOIZA, PUERTO RICO, JULY 1985.

Geological Survey, San Juan, PR. Water Resources Div.
F. Quinones, B. Green, and L. Santiago.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4019, 1989. 17p, 9 fig, 5 tab, 10 ref.

Descriptors: *Reservoirs, *Sedimentation, *Reservoir siltation, *Puerto Rico, Lago Loiza, Reservoir capacity.

A survey of the sedimentation of Lago Loiza (Carraizo), in north-central Puerto Rico was conducted during July 1985. The survey showed that the actual capacity of the reservoir has declined from 21,700 acre-ft in 1953 to about 10,100 acre-ft in 1985. Sedimentation is depleting the reservoir's capacity at an average rate of about 439 acre-ft/yr, or about 1.8%/yr of the original capacity. The increase in capacity of 2,400 acre-ft produced in 1977 when flashboards were installed, has now been nullified by sedimentation. Under optimal conditions the remaining usable life of the reservoir is estimated to be about 23 years. (Author's abstract)
W90-05546

LITHOLOGY, MINERALOGY, AND PALEONTOLOGY OF QUATERNARY LAKE DEPOSITS IN LONG VALLEY CALDERA, CALIFORNIA.

Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W90-05551

COMPOSITION, DISTRIBUTION, AND HYDROLOGIC EFFECTS OF CONTAMINATED SEDIMENTS RESULTING FROM THE DIS-

Field 2—WATER CYCLE

Group 2J—Erosion and Sedimentation

CHARGE OF GOLD MILLING WASTES TO WHITEWOOD CREEK AT LEAD AND DEADWOOD, SOUTH DAKOTA.

Geological Survey, Rapid City, SD. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05553

SEDIMENTATION SURVEY OF LAGO DOS BOCAS, PUERTO RICO, JUNE 1985.

Geological Survey, San Juan, PR. Water Resources Div.
F. Quinones, F. Melendez, and C. Bonnet.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 86-241, 1989. 14p, 6 fig, 3 tab, 5 ref.

Descriptors: *Puerto Rico, *Reservoirs, *Sedimentation, *Lago Dos Bocas, *Reservoir silting, Reservoir sediments, Reservoir capacity.

A survey of the sedimentation of Dos Bocas reservoir, in central Puerto Rico, was conducted during July 1985. The survey showed that the capacity of the reservoir has declined from 30,420 acre-ft in 1942 to about 19,620 acre-ft. Sediment is accumulating in the reservoir at an average rate of about 251 acre-ft/yr, or about 0.83%/yr of the original capacity. The expected usable life of the reservoir on the basis of the long-term sedimentation rate is about 78 years. However, the sedimentation rate appears to have increased significantly since 1979. During the last six years, the average sedimentation rate has exceeded 600 acre-ft/yr. If this rate is maintained, the expected usable life of the reservoir would be about 32 years. (Author's abstract)
W90-05608

SEDIMENT TRANSPORT AND ACCRETION AND THE HYDROLOGIC ENVIRONMENT OF GROVE CREEK NEAR KENANSVILLE, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.
T. C. Stametz.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4086, 1989. 30p, 10 fig, 6 tab, 12 ref.

Descriptors: *Sediment transport, *North Carolina, *Silt, *Grove Creek, Hydrologic systems, Grove Creek Basin, Clays, Silt, Trees, Radioisotopes, Cesium, Lead, Cores, Sediment analysis.

The Grove Creek basin includes an area of about 42 sq mi in Duplin County, North Carolina. This report evaluates sediment transport and sediment accretion rates in the lowermost 9-mile reach of Grove Creek by using hydrologic, dendrologic, and radioisotopic data collected at seven sites along the study reach. Hydrologic data indicate two discharge frequencies. In the swampiest reaches downstream of site 5, inundation occurs 35% of the time; above this site, inundation occurs about 15% of the time. For the period from October 1982 through September 1987, overbank flows at site 4 occurred 82 times and lasted a total of 632 days with a maximum duration of 3 months. Distribution of tree species indicates that water tolerant bald cypress have developed along the lowermost 7 miles of Grove Creek where the flood plain is inundated 35% of the time. The sediment that is transported in Grove Creek is predominantly silt and clay. Measured suspended sediment concentrations at discharges < 100 cu ft/sec are < 15 mg/L; concentrations at higher discharges did not exceed 67 mg/L. Calculated suspended sediment loads ranged from 75 to 444 tons/yr at the various data collection sites on Grove Creek. Sediment accretion rates estimated from dendrologic data ranged from 0.03 ft/yr to 0.06 ft/yr. The highest accretion rates occur in the downstream swampy reaches and are due to channel braiding, low channel gradients and flow velocities, and high frequency and duration percentages of overbank flow, which result in the deposition of clay and silt over wide areas of the flood plain. Sediment accretion rates along Grove Creek were also estimated by radioisotope methods. Sediment cores from the

flood plain showed detectable levels of 137-Ce, 210-Pb, and 226-Ra. 137-Ce was not present in the sediment cores below a depth of 10 inches; this indicates a maximum accretion rate of about 0.024 ft/yr for the period 1952-87. 21-Pb and 226-Ra data from these same sediment cores indicate an average accretion rate of 0.026 ft/yr to a depth of about 2 ft. The maximum age of the floodplain sediment at the 2-ft level is about 80 years. (Author's abstract)
W90-05609

2K. Chemical Processes

GEOCHEMISTRY AND ISOTOPE HYDROGEOLOGY OF THE MOUNT EDZIZA-MESS CREEK GEOTHERMAL AREA.

Piteau (D.R.) and Associates Ltd., Vancouver (British Columbia).
For primary bibliographic entry see Field 8E.
W90-04585

SLOPE AND PHOSPHOGYPSUM'S EFFECTS ON RUNOFF AND EROSION.

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 2J.
W90-04626

DIFFUSION METHODS FOR THE DETERMINATION OF REDUCED INORGANIC SULFUR SPECIES IN SEDIMENTS.

Florida Agricultural and Mechanical Univ., Tallahassee. Div. of Agricultural Science.
For primary bibliographic entry see Field 7B.
W90-04654

SEASONAL GEOCHEMISTRY OF AN ARCTIC TUNDRA DRAINAGE BASIN.

Ohio State Univ., Columbus. Dept. of Agronomy.
K. R. Everett, G. M. Marion, and D. L. Kane.
Holartic Ecology HOECD2, Vol. 12, No. 3, p 279-289, Oct 1989. 8 fig, 5 tab, 19 ref.

Descriptors: *Geochemistry, *Small watersheds, *Tundra, *Arctic zone, Seasonal variation, Snowmelt, Flood peak, Ions.

The snowmelt flood at Imnavait Creek takes place sometime between 12 May and 2 June and constitutes the single most important hydrological and geochemical event. Three years of study indicate this event spans 7 to 10 days and that peak discharge can be expected to be between 0.6 and 0.9 cu. m. Ion concentrations peak during the first 15% of the event while pH is at a minimum. In all cases, ion concentrations in the spring runoff are 4 to 9 times those of the snow pack. Precipitation, including dryfall, contributes significant amounts of Ca, Mg, K, Na, Cl and SO₄. Potassium is present in surface waters only during melt-off and for a short time after. Calcium, Mg, suspended solids and electrical conductivity all reach broad, poorly defined peaks in mid-summer. Only pH shows a significant relationship to discharge. On a seasonal basis a substantial charge imbalance favoring cations occurs. It seems probable that the, as yet, unmeasured negative charge is associated with organic anions. No seasonal trends were recorded for Mg, K or Mn in subsurface flow in the surrounding slopes. Calcium, Fe and Al showed a late season peak, and the concentration of Na and Si decreased as the melt season progressed. (Author's abstract)
W90-04715

EFFECT OF NUTRIENT AND WATER ADDITIONS ON ELEMENTAL MOBILITY THROUGH SMALL TUNDRA WATERSHEDS.

San Diego State Univ., CA. Systems Ecology Research Group.
G. M. Marion, and K. R. Everett.
Holartic Ecology HOECD2, Vol. 12, No. 3, p 317-323, Oct 1989. 4 fig, 3 tab, 16 ref. DOE Grant No. DE-FG03-84ERGO250.

Descriptors: *Experimental basins, *Solute transport, *Water chemistry, *Ecology, *Environmen-

tal effects, Nutrients, Ions, Tundra, Ecological effects.

The objective was to quantify elemental movement through small tundra watersheds as affected by nutrient and water additions. Nutrient (slow-release nitrogen/phosphorus/potassium fertilizer) and water additions were applied to small tundra watersheds along Imnavait Creek Northern Alaska. Suction lysimeters and weired watersheds were used to monitor elemental mobility. Elemental concentrations in undisturbed watersheds were similar to Hubbard Brook watersheds except for nitrate-N which was much higher and phosphate-P which was lower in the Hubbard Brook watersheds. The water addition treatment led to a significant increase in Ca, Mg, Na, Fe, Mn and sulfate concentrations which was attributed to contamination originating from within the water distribution system. Increased elemental concentrations in the irrigated watersheds were found up to 85 m below the point of application. Ammonium and nitrate originating from the fertilizer were detected 6 m below the application point within two weeks of application. The ammonium and nitrate concentrations remained above background levels for two field seasons following fertilization. Both the irrigation and fertilization studies show that disturbances in tundra ecosystems may spread far beyond the initially impacted area both with respect to time and space. (Author's abstract)
W90-04718

COMPARATIVE EFFECTS OF DOWNSLOPE WATER AND NUTRIENT MOVEMENT ON PLANT NUTRITION, PHOTOSYNTHESIS, AND GROWTH IN ALASKAN TUNDRA.

Florida International Univ., Miami. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2E.
W90-04719

DISSOLVED ORGANIC CARBON DYNAMICS OF DEVELOPED AND UNDEVELOPED WETLAND CATCHMENTS IN WESTLAND, NEW ZEALAND.

Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-04805

PREDICTION OF LONG-TERM EFFECTS OF RAINWATER ACIDITY ON PEAT AND ASSOCIATED DRAINAGE WATER CHEMISTRY IN UPLAND AREAS.

Aberdeen Univ. (Scotland). Dept. of Plant and Soil Science.
For primary bibliographic entry see Field 5C.
W90-04834

CHEMICAL SUBSTITUTION REACTION BETWEEN CU(II) AND HG(II) AND HYDROUS CDS(S).

Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-04841

EFFECT OF SURFACE ACTIVE SUBSTANCES ON THE ELECTROCHEMICAL BEHAVIOUR OF COPPER IONS IN CHLORIDE SOLUTIONS AND IN NATURAL WATERS.

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
N. Plavsic, and B. Cosovic.
Water Research WATRAG, Vol. 23, No. 12, p 1545-1553, December 1989. 9 fig, 29 ref. National Institute for Science and Technology Grant NIST JF 849.

Descriptors: *Water chemistry, *Path of pollutants, *Surfactants, *Chlorides, *Electrochemistry, *Copper, *Natural waters, Metal complexes, Humic acids, Cations, Proteins, Chemical reactions, Electrodes, Mercury, Adsorption, Oxidation.

Chemical Processes—Group 2K

Electrochemical methods have been used in the study of the adsorption behavior of different surface active substances, biogenic and non-biogenic, as well as in the study of their complexation properties for copper ions in chloride solutions and in natural waters. The influence on the anodic oxidation wave of copper has been examined. For surface active substances (humic substances and proteins), which at the same time exhibit complexation properties towards copper ions, the main interaction will be complexation, especially in the lower concentration range of both copper and the organic substance. At higher concentrations of the surface active substances and copper ions adsorption effects may play a role in oxido-reduction processes of copper at the electrode surface covered with organic coating. Contrary to cadmium, the electrode reaction of copper is not greatly influenced by synthetic surface active substances like Triton X-100 and sodium dodecylsulfate, since in the potential range of the anodic wave of copper most synthetic surface active substances are desorbed from the mercury electrode surface. In natural samples the main interaction will be complexation of copper ions with organic matter. Investigations of the interfacial interactions between copper and organic coating have to be continued on the other surfaces, natural and/or model ones, which have different surface properties and will be of greater environmental significance. Mercury electrode/solution interface is not a very convenient model for the study of interfacial interactions of copper ions because of the nature of the electrode process of copper. (Author's abstract)

W90-04843

ZN SOLUBILITY IN LOW CARBONATE SOLUTIONS.

National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.

A. J. Paulson, M. M. Benjamin, and J. F. Ferguson.

Water Research WATRAG, Vol. 23, No. 12, p 1563-1569, December 1989. 5 fig, 4 tab, 18 ref.

Descriptors: *Water chemistry, *Zinc, *Carbonates, *Solubility, *Chemical precipitation, *Wastewater treatment, Hydrozincite, Chemical reactions, Zinc oxide, Heavy metals, Hydrogen ion concentration, X-ray diffraction, Heavy metals.

While the importance of several metal basic carbonates has been recognized in natural and wastewater systems, the existence of the Zn basic carbonate, hydrozincite, has not been fully appreciated even though solubility data have been available. In the presence of 2 mM total inorganic carbonate, Zn(++) solutions below pH 8.2 were found to precipitate hydrozincite within 24 hours and to contain total dissolved Zn concentrations that were comparable to those predicted from equilibrium with hydrozincite. The identity of the hydrozincite was confirmed by X-ray diffraction and elemental analyses. In the pH range 8.2 to 10.5, the total dissolved Zn concentrations were less than that expected from equilibrium with hydrozincite by factors of up to 3, while the precipitated solids had C:Zn ratios intermediate between those of hydrozincite, give oxide, and exhibited weak hydrozincite X-ray diffraction patterns. At pHs above 10.3, zinc oxides with strong X-ray diffraction patterns were present and total dissolved Zn concentrations approached those expected for equilibrium with zinc oxide. In solutions prepared to exclude carbonate, the total dissolved zinc concentrations in all solutions were similar to those expected for equilibrium with zinc oxide. However, two solids in these 'carbonate-free' solutions contained small amounts of inorganic carbonate and exhibited weak hydrozincite X-ray diffraction patterns. The presence of well-defined or poorly-crystalline hydrozincite in all 2 mM inorganic carbon solutions between pH 8 to 10 and its presence in two solutions prepared to exclude carbonate contamination suggest that hydrozincite is probably a common Zn solid formed in conventional precipitation processes. (Author's abstract)

W90-04845

STRUCTURAL INVESTIGATIONS OF AQUATIC HUMIC SUBSTANCES BY PYROLYSIS-

FIELD IONIZATION MASS SPECTROMETRY AND PYROLYSIS-GAS CHROMATOGRAPHY/MASS SPECTROMETRY.

Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.

For primary bibliographic entry see Field 7B.

W90-04847

EXAMINATION OF A FRESHWATER SURFACE MICROLAYER FOR DIEL CHANGES IN THE BACTERIOTRANSFER.

Wisconsin Univ., Milwaukee. Center for Great Lakes Studies.

For primary bibliographic entry see Field 2H.

W90-04886

MASS TRANSFER PROPERTIES OF THE BENTHIC BOUNDARY LAYER WITH AN APPLICATION TO OXYGEN FLUXES.

Sveriges Meteorologiska och Hydrologiska Inst., Norrköping.

For primary bibliographic entry see Field 2H.

W90-05033

INSTREAM CHEMICAL REACTIONS OF ACID MINE WATER ENTERING A NEUTRAL STREAM NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.

For primary bibliographic entry see Field 5B.

W90-05067

HYDROXYL RADICAL FORMATION IN ST. KEVIN GULCH, AN IRON-RICH STREAM IN COLORADO.

Geological Survey, Denver, CO.

For primary bibliographic entry see Field 5B.

W90-05073

SOLUTE DIFFUSION WITHIN SAND OF THE CAPE COD, MASSACHUSETTS, AQUIFER.

Geological Survey, Reston, VA.

For primary bibliographic entry see Field 5B.

W90-05077

INFLUENCE OF GEOCHEMICAL HETEROGENEITY IN A SAND AND GRAVEL AQUIFER ON THE SORPTION OF CHLOROBENZENES.

Geological Survey, Denver, CO.

For primary bibliographic entry see Field 5B.

W90-05079

FIELD AND LABORATORY STUDIES OF COUPLED FLOW AND CHEMICAL REACTIONS IN THE GROUND-WATER ENVIRONMENT.

Geological Survey, Menlo Park, CA.

For primary bibliographic entry see Field 2F.

W90-05081

COUPLED CHEMICAL, BIOLOGICAL AND PHYSICAL PROCESSES IN WHITEWOOD CREEK, SOUTH DAKOTA: EVALUATION OF THE CONTROLS OF DISSOLVED ARSENIC.

Geological Survey, Menlo Park, CA.

For primary bibliographic entry see Field 5B.

W90-05087

USE OF RADON-222 AS A TRACER OF TRANSPORT ACROSS THE BED SEDIMENT-WATER INTERFACE IN PRIEN LAKE, LOUISIANA.

Geological Survey, Baton Rouge, LA.

For primary bibliographic entry see Field 5B.

W90-05092

PHASE ASSOCIATION OF TRACE METALS IN SEDIMENTS FROM THE CALCASIEU RIVER, LOUISIANA.

Geological Survey, Reston, VA.

For primary bibliographic entry see Field 5B.

W90-05093

ABIOTIC PHOTOLYSIS IN THE CALCASIEU RIVER, LOUISIANA.

Geological Survey, Reston, VA.

For primary bibliographic entry see Field 5B.

W90-05096

SOLUBILITY OF ALUMINUM AND IRON IN GROUND WATER NEAR GLOBE, ARIZONA.

Geological Survey, Denver, CO.

For primary bibliographic entry see Field 2F.

W90-05123

CHEMICAL CHARACTERISTICS, INCLUDING STABLE-ISOTOPE RATIOS, OF SURFACE WATER AND GROUNDWATER FROM SELECTED SOURCES IN AND NEAR EAST FORK ARMELLS CREEK BASIN, SOUTHEASTERN MONTANA, 1985.

Geological Survey, Helena, MT. Water Resources Div.

R. F. Ferreira, J. H. Lambing, and R. E. Davis.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4024, August, 1989. 51p, 13 fig, 10 tab, 14 ref.

Descriptors: *Coal mining effects, *Water quality, *Groundwater quality, *Montana, Stable isotopes, Armells Creek, Dissolved solids, Surface water, Trace elements.

Water samples were collected from 29 sites to provide synoptic chemical data, including stable-isotope ratios, for an area of active surface coal mining and to explore the effectiveness of using the data to chemically distinguish water from different aquifers. Surface-water samples were collected from one spring, four sites on East Armells Creek, one site on Stocker Creek, and two fly-ash ponds. Streamflows in East Fork Armells Creek ranged from no flow in several upstream reaches to 2.11 cu ft/sec downstream from Colstrip, Montana. Only one tributary, Stocker Creek, was observed to contribute surface flow in the study area. Groundwater samples were collected from wells completed in Quaternary alluvium or mine spoils, Rosebud overburden, Rosebud coal bed, McKay coal bed, and sub-McKay deposits of the Tongue River Member, Paleocene Fort Union Formation. Dissolved-solids concentrations, in mg/L, were 840 at the spring, 3,100 to 5,000 in the streams, 13,000 to 22,000 in the ash ponds, and 690 to 4,100 in the aquifers. With few exceptions, water from the sampled spring, streams, and wells had similar concentrations of major constituents and trace elements and similar stable-isotope ratios. Water from the fly-ash ponds had larger concentrations of dissolved solids, boron, and manganese and were isotopically more enriched in deuterium and oxygen-18 than water from other sources. Water from individual aquifers could not be distinguished by either ion-composition diagrams or statistical cluster analyses. (USGS)

W90-05204

APPRAISAL OF GROUND-WATER QUALITY IN THE BUNKER HILL BASIN OF SAN BERNARDINO VALLEY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.

For primary bibliographic entry see Field 2F.

W90-05211

CORROSIVE GROUNDWATER IN THE KIRKWOOD-COHANSEY AQUIFER SYSTEM IN THE VICINITY OF OCEAN COUNTY, EAST-CENTRAL NEW JERSEY.

Geological Survey, Trenton, NJ. Water Resources Div.

G. R. Kish, J. L. Barringer, and R. L. Ulery.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4181, 1989. 1 sheet, 4 fig, 1 tab, 19 ref.

Descriptors: *Corrosion, *Atlantic Coastal Plain, *Water quality, *New Jersey, Hydrogen ion concentration, Groundwater, Alkalinity, Ocean

Field 2—WATER CYCLE

Group 2K—Chemical Processes

County, Kirkwood-Cohansey Aquifer System, Aggressive index.

Corrosive groundwater, which has been linked to trace-metal leaching from plumbing materials in Europe and the United States, has been identified in the Coastal Plain of New Jersey. The corrosiveness of groundwater in the Kirkwood-Cohansey aquifer system in New Jersey has been estimated by calculating values for the Aggressive Index, using groundwater chemistry data. A contour map of Aggressive-Index values shows that groundwater is very corrosive in the vicinity of Ocean County, New Jersey. Areas with the least corrosive water are generally along the coast, whereas areas with the most corrosive water are farther inland. (USGS)
W90-05275

EVALUATION OF FIELD SAMPLING AND PRESERVATION METHODS FOR STRONTIUM-90 IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.
For primary bibliographic entry see Field 5A.
W90-05278

SELECTED WATER-QUALITY CHARACTERISTICS AND FLOW OF GROUNDWATER IN THE SAN LUIS BASIN, INCLUDING THE CONEJOS RIVER SUBBASIN, COLORADO AND NEW MEXICO.

Geological Survey, Denver, CO. Water Resources Div.
R. S. Williams, and S. E. Hammond.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4040, 1990. 43p, 12 fig, 1 pl, 5 tab, 18 ref.

Descriptors: *Water quality, *Geochemistry, *Colorado, *New Mexico, *Water resources data, Unconfined aquifers, Confined aquifers, Springs, Rivers.

Chemical analysis of water from 99 wells and 19 springs in the San Luis basin in Colorado and New Mexico were evaluated to determine selected water quality characteristics as an aid in understanding the flow of groundwater in the basin. The evaluation shows that the distribution of chemical water types in the basin is consistent with chemical changes to be expected along flow paths in rocks typical of those in the basin. The San Luis basin area is underlain by a surficial (less than 100 ft thick) unconfined aquifer and, in turn, by a confining bed and a deeper confined aquifer. Previous studies have indicated that the groundwater system is recharged around the edges of the basin and that groundwater then moves toward discharge areas in the topographically closed part of the basin and along principal streams. Results of this groundwater quality evaluation support these previously developed concepts of flow through the aquifer system in the San Luis basin. (USGS)
W90-05280

HYDROLOGIC AND CHEMICAL DATA FOR SELECTED THERMAL-WATER WELLS AND SPRINGS IN THE INDIAN BATHTUB AREA, OWYHEE COUNTY, SOUTHWESTERN IDAHO.

Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-05282

INFLUENCE OF SALINITY, LEACHING FRACTION, AND SOIL TYPE ON OXYGEN DIFFUSION RATE MEASUREMENTS AND ELECTRODE *POISONING*.

Nevada Univ., Reno. Dept. of Plant Science.
For primary bibliographic entry see Field 7B.
W90-05307

INTERACTION IN AQUEOUS SOLUTION OF CERTAIN PESTICIDES WITH FULVIC ACIDS FROM A SPODOSOL SOIL.

Instituto de Recursos Naturales y Agrobiologia, Seville (Spain).
For primary bibliographic entry see Field 5B.
W90-05308

COMPARISON OF ALUMINIUM PREPARATIONS AS COAGULANTS IN WATER TREATMENT.

Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-05315

STABLE ISOTOPE COMPOSITION OF LAND SNAIL BODY WATER AND ITS RELATION TO ENVIRONMENTAL WATERS AND SHELL CARBONATE.

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2H.
W90-05325

DISSOLUTION OF CALCITE IN ACID WATERS: MASS TRANSPORT VERSUS SURFACE CONTROL.

Oxford Univ. (England). Physical Chemistry Lab.
For primary bibliographic entry see Field 5G.
W90-05362

EFFECT OF REDOX POTENTIAL ON FIXATION OF 137 CESIUM IN LAKE SEDIMENT.

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
For primary bibliographic entry see Field 5B.
W90-05367

LIMNOLOGICAL RECONNAISSANCE OF WATER BODIES IN CENTRAL AND SOUTHERN NEPAL.

Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W90-05371

CHEMISTRY OF HIGH MOUNTAIN LAKES IN SILICEOUS CATCHMENTS OF THE CENTRAL EASTERN ALPS.

Institut fuer Limnologie, Mondsee (Austria).
For primary bibliographic entry see Field 2H.
W90-05386

GEOCHEMICAL EVOLUTION OF HALITE STRUCTURES IN HYPERSALINE LAKES: THE DEAD SEA, ISRAEL.

Hebrew Univ., Jerusalem (Israel). Dept. of Geology.
For primary bibliographic entry see Field 2H.
W90-05391

SOLUBILITY OF HALITE AS A FUNCTION OF TEMPERATURE IN THE HIGHLY SALINE DEAD SEA BRINE SYSTEM.

Hebrew Univ., Jerusalem (Israel). Dept. of Geology.
For primary bibliographic entry see Field 2H.
W90-05392

BACKGROUND CONCENTRATION RANGES OF HEAVY METALS IN SWEDISH GROUNDWATERS FROM CRYSTALLINE ROCKS: A REVIEW.

Linköping Univ. (Sweden). Dept. of Water and Environmental Research.
A. Ledin, C. Pettersson, B. Allard, and M. Aastrup.
Water, Air and Soil Pollution WAPLAC, Vol. 47, No. 3-4, p 419-426, October 1989. 4 fig, 2 tab, 27 ref.

Descriptors: *Water chemistry, *Geochemistry, *Baseline studies, *Heavy metals, *Crystalline

rocks, *Sweden, Trace metals, Chromium, Copper, Zinc, Cadmium, Lead, Igneous rocks, Hydrogen ion concentration, Bedrock, Sulfides.

Concentrations of heavy metals (Cr, Cu, Zn, Cd, and Pb) in groundwaters, primarily from igneous crystalline bedrock, were studied in 126 Swedish groundwater sources that were considered relatively free of pollution. Heavy metal occurrence was summarized in a cumulative frequency plot and was also analyzed against groundwater pH. Results show that the observed groundwater concentrations of the metals are generally at least qualitatively related to concentration levels of the metals in the bedrock as well as to pH of the water. At low pH corresponding to a slight acidification in otherwise unpolluted groundwaters, concentration levels up to 2 (Cr), 9 (Cu), 100 (Zn), 0.3 (Cd), and 1 (Pb) microgram/liter were observed. The natural variations in heavy metal concentrations in groundwaters from crystalline granitic rocks are at least one order of magnitude, with probable background concentrations of 0.03 to 0.5 (Cr), 0.2 to 4 (Cu), 0.8 to 30 (Zn), 0.003 to 0.1 (Cd), and 0.01 to 0.2 (Pb) micrograms/liter in non-sulfidic waters. The presence of sulfide in solution would reduce the levels to < nanograms/liter, except for Cr. (Geiger-PTT)
W90-05413

NUTRIENT CYCLING AT THE LAND-WATER INTERFACE: THE IMPORTANCE OF THE RIPARIAN ZONE.

Oregon State Univ., Corvallis. Dept. of Rangeland Resources.
For primary bibliographic entry see Field 4C.
W90-05501

SELECTED WATER-QUALITY CHARACTERISTICS AND FLOW OF GROUND WATER IN THE SAN LUIS BASIN, INCLUDING THE CONEJOS RIVER SUBBASIN, COLORADO AND NEW MEXICO.

Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-05593

ORGANIC GEOCHEMISTRY AND BRINE COMPOSITION IN GREAT SALT, MONO, AND WALKER LAKES.

Johns Hopkins Univ., Baltimore, MD. Dept. of Earth and Planetary Sciences.
J. L. Domagalski, W. H. Orem, and H. P. Eugster.
Pergamon Press, New York, New York. November 1989. 16p, 10 fig, 6 tab, 44 ref. NSF Grant EAR-87-06384.

Descriptors: *Saline lakes, *Water chemistry, *Geochemistry, *Brines, *Great Salt Lake, *Mono Lake, *Walker Lake, *Sediment chemistry, Organic carbon, Humic substances, Algae, Organic matter, Sulfates.

Samples of recent sediments, representing up to 1000 years of accumulation, were collected from three closed basin lakes (Mono Lake, Ca, Walker Lake, NV, and Great Salt Lake, UT) to assess the effects of brine composition on the accumulation of total organic carbon, the concentration of dissolved organic carbon, humic acid structure and diagenesis, and trace metal complexation. The Great Salt Lake water column is a stratified Na-Mg-Cl-SO₄ brine with low alkalinity. Algal debris is entrained in the high density (1.132-1.190g/ml) bottom brines, and in this region maximum organic matter decomposition occurs by anaerobic processes, with sulfate ion as the terminal electron acceptor. Organic matter, below 5 cm of the sediment-water interface, degrades at a very slow rate in spite of very high pore-fluid sulfate levels. Mono Lake is an alkaline (Na-CO₃-Cl-SO₄) system. The water column is stratified, but the bottom brines are of lower density relative to the Great Salt Lake, and sedimentation of algal debris is rapid. Walker Lake is also an alkaline system. The water column is not stratified, and decomposition of organic matter occurs by aerobic processes at the sediment-water interface and by anaerobic processes

es below. Total organic carbon and dissolved organic carbon concentrations in Walker Lake sediments vary with location and depth due to changes in input and pore-fluid sulfate concentrations. Nuclear magnetic resonance studies (13-C) of humic substances and dissolved organic carbon provide information on the source of the recent sedimentary organic carbon (aquatic vs. terrestrial), its relative state of decomposition, and its chemical structure. The spectra suggest an algal origin with little terrestrial signature at all three lakes. Despite very high algal productivities, organic carbon accumulation can be low in stratified lakes if the anoxic bottom waters are hypersaline with high concentrations of sulfate ion. Labile organic matter is recycled to the water column and the sedimentary organic matter is relatively nonsusceptible to bacterial metabolism. As a result, pore-fluid dissolved organic carbon and metal-organic complexation are low. (Lantz-PTT)
W90-05595

EVALUATION OF METHODS USED FROM 1965 THROUGH 1982 TO DETERMINE INORGANIC CONSTITUENTS IN WATER SAMPLES.

For primary bibliographic entry see Field 7B.
W90-05619

2L. Estuaries

EVOLUTION OF THE UPPER PART OF THE ESTUARY OF THE CASAMANCE RIVER (SENEGAL): TOWARD A PECULIAR EVAPORATORY MARINE SYSTEM. ISOTOPIC DATA OF WATERS, (EVOLUTION DU HAUT ESTUAIRE DE LA CASAMANCE (SENEGAL): VERS UN SYSTEME EVAPORATOIRE MARIN. DONNEES ISOTOPIQUES SUR LES EAUX LIBRES).

Paris-6 Univ. (France). Dept. de Geologie Dynamique.
C. Jussierand, J. Pages, and J. Debenay.
Comptes Rendus de l'Academie des Sciences (Serie 2), Vol. 309, No. 10, p 1101-1106, September 28 1989. 4 fig, 17 ref. English summary.

Descriptors: *Saline-freshwater interfaces, *Estuaries, *Saline water, *Isotope studies, *Africa, *Sahel, Saline water barriers, Water analysis, Hydrologic cycle, Salinity.

In the Sahelian zone of West Africa, the rain deficit since 1969-1970 induced a particular behavior of the river flood regime. For small and flat drainage basins located in a same climatic zone, such as the Casamance River (South Senegal), the natural regime is a hydrological equilibrium between sea water invasion brought by tides and either a seasonal input due to precipitation and runoff or a continuous input due to groundwater migration of water. For more than ten years, however, a new hydrological regime has occurred, governed only by sea water invasion and evaporation of water bodies. Isotopic composition of H₂ and O₁₈ and salinity were measured during two sampling periods, representing the beginning and end of the dry season. It was found that evaporation of the runoff water is compensated by an invasion of sea water, which results in an increased salinity and significant isotopic enrichment of H₂ and O₁₈. On the date sampled the instantaneous picture of chloride content and isotopic composition of water bodies in the space along the estuary was equivalent to a temporal isotopic evolution of a unique well mixed basin with reduced volume due to evaporation. The rain deficit in the Sahel region of Africa involves, in the upper part of the Casamance River estuary, this invasion of sea water. This hyperhaline paralic system serves as a natural laboratory due to its size, its high salinity, and its isotopic behavior. (Friedmann-PTT)
W90-04556

ESTUARINE COHESIVE SEDIMENT SUSPENSION BEHAVIOR.
Florida Univ., Gainesville. Coastal and Oceanographic Engineering Lab.
A. J. Mehta.

Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,303-14,314, October 15 1989. 14 fig, 1 tab, 34 ref.

Descriptors: *Estuaries, *Sediment transport, *Sedimentation, Mud, Marl, Bottom sediments, Advection, Deposition, Estuarine environment, Hydrodynamics, Sediment distribution.

Several transport processes must be considered in any evaluation of the behavior of cohesive sediments in estuaries influenced by currents and waves. Focusing on the need to understand the evolution of the suspension concentration profiles to hydrodynamic forcing, it is shown that a physical framework identifying the various mass transport components that govern suspension profile dynamics is beginning to emerge. Fluid mud rheological behavior appears to conform to a pseudoplastic (shear thinning) or dilatant (shear thickening) description with respect to the stress rate of strain relationship, depending upon mud composition, concentration, and rate of shearing. However, under conditions contingent upon, among other factors, the time scale of interest, the material has been treated either as a fluid or as a Bingham plastic. The knowledge of these components, including those associated with the generation, transport, and dewatering of fluid muds, remains incomplete. A combination of field and laboratory-based research is essential for providing data bases free of significant lacunae and for resolving major interpretative ambiguities that arise from laboratory to prototype scaling and from practical limits to field measurements. (Author's abstract)
W90-04561

BED LOAD TRANSPORT OF SAND MIXTURES IN ESTUARIES: A REVIEW.

Old Dominion Univ., Norfolk, VA. Dept. of Oceanography.

J. C. Ludwick.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,315-14,326, October 15 1989. 8 fig, 21 ref, append.

Descriptors: *Estuaries, *Sediment transport, *Bottom sediments, *Sediment load, *Deposition, *Bed load, Sand, Marine sediments, Sediment distribution, Particle size, Fluid mechanics.

Real estuaries are fundamentally inhomogeneous. This is evident in their irregular boundaries, waters of varying density, fluid motions that arise from multiple unsteady forcings, and sediments that are mixtures of various grain sizes. The influence of one of these heterogeneities, mixed particle size, on the transport of sand as bed load, is reviewed. The review includes essential early studies and recent complete theories. Present-day investigators commonly assume a reference transport function (RTF) which is an established formulation for the flux of bed load under steady unidirectional flow over a substrate of monosized particles. The aim of the modern work is to develop a procedure that yields tailored values of sheltering-exposure coefficients for the different size fractions. These coefficients are correction factors which, when applied to the acting bed shear, permit the use of the RTF to compute fraction transports over a mixed bed. There are strong interactions among the various size fractions; for instance, minor admixture of a coarse-end ingredient disproportionately reduces the overall mobility of a finer-grained bed. However, coarse fractions are more mobile in a bed of mixed sizes than they are in a bed of the same uniform size. Recommendations are made for an estuarine field study utilizing a modified Helley-Smith bed load yield sampler. (Author's abstract)
W90-04562

SEDIMENT PROCESSES IN ESTUARIES: FUTURE RESEARCH REQUIREMENTS.

Plymouth Polytechnic (England). Inst. of Marine Studies.

K. R. Dyer.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,327-14,339, October 15 1989. 6 fig, 40 ref.

Descriptors: *Estuaries, *Sediment transport, *Deposition, *Bed load, *Sediment distribution,

Bottom sediments, Sedimentation, Mud flats, Model studies, Erosion, Particle size.

The gaps in current understanding of the erosion, transport and deposition of sediment in estuaries is reviewed. It is concluded that future work should give priority to: (1) the formation, movement, and entrainment of high concentration near bed layers; (2) particle interactions, including flocculation, cycling processes, and chemical and biological interactions; (3) intertidal mudflat processes, sediment exchanges in shallow water and wave induced mud transport; (4) development of improved parameterization of exchange processes for inclusion in 3D mathematical models; and (5) development and use of new instrumentation for field measurements, especially for intermittent events, and over the long term. This work should be carried out within interdisciplinary studies involving physicists, sediment dynamicists, biologists, and chemists. (Author's abstract)
W90-04563

RESEARCH ON EROSION PROPERTIES OF COHESIVE SEDIMENTS.

Waterloopkundig Lab. te Delft (Netherlands).

For primary bibliographic entry see Field 2J.

W90-04564

GEOMORPHOLOGIC AND SEDIMENT TRANSPORT CHARACTERISTICS OF THE MIDDLE REACH OF THE BAHIA BLANCA ESTUARY (ARGENTINA).

Instituto Argentino de Oceanografia, Bahia Blanca.

G. M. E. Perillo, and M. E. Sequeira.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,351-14,362, October 15 1989. 10 fig, 29 ref.

Descriptors: *Geomorphology, *Channel morphology, *Sediment distribution, *Sediment transport, *Estuaries, Alluvial deposits, Bottom sediments, Argentina, Deltas, Sedimentation, Alluvial fans, Sedimentary structures.

The geomorphologic and sediment transport characteristics of the middle reach of the Bahia Blanca estuary (Argentina) are presented. A large intertidal sedimentary structure divides the curved-funnel-shaped reach into the Main channel, which includes the waterway, and the Vieja channel. The right margin of the study area is bordered by a low marsh/tidal flat complex. Sedimentological and low-penetration seismic data show that the area is formed mostly by relict sediments of Pleistocene and Pliocene ages. Present-day deposits are very thin and are concentrated on the left platform between the navigation route and the intertidal structure. Comparison of detailed bathymetric surveys separated by 6.75 years resulted in a net erosion for all the area of 2,400,000 cu m. Assuming that the volume of sediments dredged from the navigation channel (510,000 cu m in 6 years) was originated on the erosional sectors of the study area, approximately 250,000 cu m/yr are still exported from the reach. Net accumulation (up to 2 m) is concentrated on the left margin, while erosional zones (up to 4.5 m) are located on the right margin of the Main channel and the middle portion of Vieja channel. Sediment transport calculations from 15 current meter stations distributed in the area indicate a net bed load transport of sand-sized material directed towards the mouth of the estuary. The results suggest that dynamically, the middle reach of the Bahia Blanca estuary does not behave as a meander as was expected from its general shape. Although a preliminary estimation may indicate that the dredged sediment may proceed from the right margin, the general circulation of the estuary indicates that all reaches interchange sediments with their adjacent sectors. Sediment deposited in the middle reach are coming from the erosional processes acting in the inner reach and on the flanks of tidal flat channels. (Author's abstract)
W90-04565

Field 2—WATER CYCLE

Group 2L—Estuaries

CALIBRATION OF A GENERAL OPTICAL EQUATION FOR REMOTE SENSING OF SUSPENDED SEDIMENTS IN A MODERATELY TURBID ESTUARY.

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7C.
W90-04566

TRANSPORT PROCESSES OF SUSPENDED MATTER DERIVED FROM TIME SERIES IN A TIDAL ESTUARY.

GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Teserhude (Germany, F.R.).
For primary bibliographic entry see Field 2J.
W90-04567

DATA INTERPRETATION AND NUMERICAL MODELING OF THE MUD AND SUSPENDED SEDIMENT EXPERIMENT 1985.

Hanover Univ. (Germany, F.R.). Inst. fuer Stroomungsmechanik und Elektronisches Rechnen im Bauwesen.
For primary bibliographic entry see Field 2J.
W90-04568

DISTRIBUTIONS OF SUSPENDED SEDIMENT AT HIGH WATER IN A MACROTIDAL ESTUARY.

Marine Biological Association of the United Kingdom, Plymouth (England).
For primary bibliographic entry see Field 2J.
W90-04569

SUSPENDED SEDIMENT TRANSPORT PROCESSES IN CUMBERLAND BASIN, BAY OF FUNDY.

Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 2J.
W90-04570

OBSERVATIONS AND MODEL OF SEDIMENT TRANSPORT NEAR THE TURBIDITY MAXIMUM OF THE UPPER SAINT LAWRENCE ESTUARY.

National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2J.
W90-04571

BEDFORMS, BED MATERIAL, AND BED-LOAD TRANSPORT IN A SALT-WEDGE ESTUARY: FRASER RIVER, BRITISH COLUMBIA.

Guelph Univ. (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-04586

ON-OFFSHORE BEDLOAD SEDIMENT TRANSPORT IN THE COASTAL ZONE.

Polish Academy of Sciences, Gdansk. Inst. Budownictwa Wodnego.
For primary bibliographic entry see Field 2J.
W90-04588

VARIATIONS OF NITROGEN NUTRIENT CONCENTRATIONS IN THE SEDIMENT PORE WATERS OF THE NORTHWESTERN MEDITERRANEAN CONTINENTAL SHELF.

Laboratoire Géodynamique Sous-Marine, Villefranche-sur-Mer (France).
F. Fernex, R. Baratie, D. Span, and L. Vandeley Fernandes.
Continental Shelf Research CSHRDZ, Vol. 9, No. 9, p 767-794, 1989. 14 fig, 1 tab, 81 ref.

Descriptors: *Diagenesis, *Continental shelf, *Nitrification, *Cycling nutrients, *Dissolved solids, *Ammonification, *Marine sediments, Nitrates, Nitrogen, Continental margin, Mediterranean Sea, Productivity, Sediment-water interfaces, Interstitial water, Seasonal variation.

Information is presented on nitrogen nutrients dissolved in the sediment pore waters of the oligotro-

phic northwestern Mediterranean Sea. The areas studied are situated in various geographical environments, adjacent to or offshore from a river mouth and on wide or narrow parts of the continental shelf. Near the pro-delta of the Rhone River, which carries about 1 Mt/y of solid matter, measurements indicate that the rate of nitrogen nutrient production (ammonification) reaches frequently, or even exceeds, 2 pmol/cu cm/s. The production rate near the mouth of the Siagne River, a mountain stream, is generally lower, at 1 pmol/cu cm/s; exceptionally, it reaches 1 to 1.5 pmol/cu cm/s. There is more temporal variation in concentrations in sediments just below the sediment-seawater boundary, than in the deeper deposits. Nitrate production rates were not measured, but can be evaluated from a model based upon Fick's Laws for Diffusion. The fact that nitrate production does not increase with depth, in the sediment, has been taken into account in modeling. The model is based upon the assumption that the nitrification rate intensity varies as a function of time, according to a Gaussian curve. The nitrification maximum occurs, in spring, in the surficial sediments. The classical partial differential equation can be approximated using finite difference analysis. For areas located at a distance from river mouths, good agreement was obtained between the derived nitrate concentrations and those measured. Maximum nitrate production rate occurs in the uppermost sediment layers (with $R_p=0.5$ to 1.5 pmol/cu cm/s). These values correspond nearly to those that have been found for surficial sediments in other countries; however, for the continental shelf of the northwestern Mediterranean Sea, the high production rate lasts for only short periods throughout the year. (Author's abstract)
W90-04590

MASS BALANCE OF BIOGEOCHEMICALLY ACTIVE MATERIALS (C, N, P) IN A HYPER-SALINE GULF.

Hawaii Inst. of Marine Biology, Honolulu.
S. V. Smith, and H. H. Veeh.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 3, p 195-215, September 1989. 6 fig, 3 tab, 47 ref.

Descriptors: *Estuaries, *Estuarine environment, *Cycling nutrients, *Geochemistry, *Biochemistry, *Gulfs, *Saline water systems, Carbon, Nitrogen, Phosphorus, Air-water interfaces, Australia, Aquatic environment.

Inverse estuaries tend to have long water residence time and little hydrographic input of materials. Yet such systems can support apparently normal marine communities. Slow net fluxes over long timespans substantially alter water composition, so such systems provide an opportunity to study system-scale characteristics of net material fluxes. The mass balance of water, salt, C, N, and P in Spencer Gulf, a large inverse estuary in South Australia, were examined. Dissolved inorganic C is taken up in Spencer Gulf by biogenic CaCO_3 precipitation and organic production. Input of C includes both hydrographic processes and gas flux across the air-sea interface. Most of the C uptake is exported as particulate organic matter; some is exported as dissolved organic matter; relatively little organic C is buried in the sediments. Virtually all dissolved inorganic P delivered to the gulf is taken up and apparently largely exported as particulate material. The major source of N appears to be the atmosphere, and dissolved organic N export exceeds dissolved inorganic N import. The fluxes of C, N, and P are biologically mediated, and a plausible interaction among these fluxes was sought. The CO_2 system appears remarkably 'balanced' by its fluxes to relatively constant pH, CO_2 concentration, and calcite saturation state. It is concluded that supply of $\text{PO}_4(3-)$ largely controls characteristics of C and N flux. The controls postulated for P include CaCO_3 precipitation, CO_2 gas flux, organic C production, and N fixation. (Author's abstract)
W90-04591

RECONSTRUCTION OF A CONCENTRATION FIELD IN A COASTAL SEA.

Institut Rudjer Boskovic, Zagreb (Yugoslavia).

For primary bibliographic entry see Field 5B.
W90-04592

BLUE CRAB MEGALOPAL INFLUX TO CHESAPEAKE BAY: EVIDENCE FOR A WIND-DRIVEN MECHANISM.

National Oceanic and Atmospheric Administration, Rockville, MD. Office of Climatic and Atmospheric Research.
D. M. Goodrich, J. van Montfrans, and R. J. Orth.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 3, p 247-260, September 1989. 7 fig, 1 tab, 30 ref. NOAA Sea Grant NA86AA-DG042.

Descriptors: *Chesapeake Bay, *Crabs, *Estuaries, *Wind-driven currents, *Wind waves, *Population density, Inflow, Outflow, Temporal distribution, Bays, Storm surges, Volumetric analysis.

Field surveys indicate that blue crab larvae and postlarvae develop in shelf waters adjacent to the Chesapeake Bay entrance, and that postlarvae return to the estuary for settlement into nursery areas. The postlarval form is the megalopae, and in the offshore area most of these are found near the surface. However, the surface mean flow at the Bay entrance is seaward. Megalopae must either drop to the bottom to become entrained in the density-driven inflow or employ another transport process in the surface. A potentially important mechanism by which these megalopae can return is through episodic wind-driven exchange, which is a prominent feature of the circulation in this region. Using sea level data, the magnitude of the wind-induced changes in Bay volume can be calculated from any period when these data are available. During 1985-87, megalopae were collected daily in the York River (a tributary of Chesapeake Bay) from August through November. Their temporal distribution was characterized by pulses of individuals, separated by periods when very few were collected. A total of 12 to 16 observed megalopal pulses occurred during positive volume anomalies. In particular, the largest peak of 1985 occurred during the massive storm surge associated with Hurricane Juan, implying large-scale transport of megalopae from the shelf. Analysis of 28 years of subtidal volume data indicates that an average of 10 major inflow events per year occur during the period when megalopae are present. This indicates that these wind-induced inflow events are not fortuitous but rather are a stable feature of the flow climate at the Bay entrance. (Author's abstract)
W90-04593

DEPOSITIONAL MODEL OF A MACROTIDAL ESTUARY AND FLOODPLAIN, SOUTH ALLIGATOR RIVER, NORTHERN AUSTRALIA.

Australian National Univ., Canberra. North Australia Research Unit.

For primary bibliographic entry see Field 2J.
W90-04613

WETLANDS AND SUBSISTENCE-BASED ECONOMIES IN ALASKA, U.S.A.

Alaska Univ., Fairbanks. Dept. of Anthropology.
L. J. Ellanna, and P. C. Wheeler.
Arctic and Alpine Research ATPAV, Vol. 21, No. 4, p 329-340, November 1989. 5 fig, 25 ref.

Descriptors: *Land use, *Wetlands, *Arctic, *Alaska, *Economic evaluation, *Rural areas, *Resources management, Public policy.

Planners, developers, conservationists and others have tended to view wetland habitats in Alaska as being 'unused'. In actuality, wetlands provide the foundation for many Alaskan Native subsistence-based economies. Social, cultural, economic, and valuatative components of Alaskan Native societies are integrated within hunting, gathering, fishing, and trapping activities, providing for a dynamic adaptive system focused on the use of local resources in wetlands. Comparative examples described in case histories of four villages (Shishmaref, Kaktovik, Alakanuk, and Tyonek) demonstrate that rural wetlands in Alaska cannot be assumed to be unused. In fact, the uses of wetland habitats and resources by rural Alaskan Natives are

subject to serious threat as a result of changing land status over the past few decades. (Author's abstract)
W90-04638

ORGANIC CARBON ISOTOPE RATIOS AND IMPLICATIONS FOR THE MAXIMUM TURBIDITY ZONE OF THE ST. LAWRENCE ESTUARY.

Quebec Univ., Montreal.
M. Lucotte.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 4, p 293-304, October 1989. 5 fig, 3 tab, 30 ref.

Descriptors: *Estuaries, *Organic carbon, *Stable isotopes, *Suspended solids, *Particulate matter, *Turbidity, *St. Lawrence Estuary, Isotope studies, Plankton, Marsh plants, Seasonal variation, Salinity, Tidal advection.

Carbon isotope ratios of suspended particulate matter of the St. Lawrence Upper Estuary exhibit a different linear correlation with the ambient salinities for each sampling period, if one excludes the stations from the early mixing zone. These relationships reflect the tidal advection of particles in the turbid zone and their conservative mixing with marine inputs. The year-round constant $\delta^{13}\text{C}$ -13 value of the marine pole (-23.6 per mil, $\text{S.D.} = 0.3$) is representative of an average long-term mixture of terrigenous particles and planktonic cells. In May, the upstream pole ($\delta^{13}\text{C}$ -13 = -26.6 per mil) is dominated by terrigenous particulate organic carbon brought by the river with the spring freshet. After spring runoff, the sedimentary exchanges between the large tidal platforms of the Cap Tourmente region and the nearby estuarine channels control the particulate organic carbon composition of the upstream pole ($\delta^{13}\text{C}$ -13 = -25.4 per mil in June to -24.4 per mil in October). The influence of this pole extends to the entire maximum turbidity zone, blurring the isotopic characteristics of the freshwater particulate organic carbon inputs. The summer fluvial planktonic production ($\delta^{13}\text{C}$ -13 = -24.0 per mil), for instance, has a negligible influence on the gradual seasonal C -13 enrichment of the upstream pole. Similarly, the debris of C_3 vascular plants growing on the marshes (*Scirpus* and *Sagittaria*) does not appear to have a dominating influence on the fall particulate organic carbon compositions of the turbid zone. The averaged-out upstream pole reflects the long residence time (6-12 months) of the particles kept in suspension in the turbid zone. (Author's abstract)
W90-04641

RUNOFF AND FLOCCULATION MODIFY UNDERWATER LIGHT ENVIRONMENT OF THE HUDSON RIVER ESTUARY.

State Univ. of New York at Albany. Dept. of Biological Sciences.
R. G. Stross, and R. C. Sokol.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 4, p 305-316, October 1989. 4 fig, 3 tab, 39 ref.

Descriptors: *Estuaries, *Light quality, *Suspended solids, *Suspended sediments, *Algae, *Flocculation, Clays, Silt, Hudson River Estuary, New York.

Spectral quality of underwater irradiance was measured in the Hudson River Estuary at 10 stations, which ranged from Albany to Battery Park, Manhattan. Incoming light is attenuated by a large, fluctuating load of terrigenous sediments and by phytoplankton. Photoc depth ranged from only 0.6 m in late winter to 4.3 m in summer. All but the yellow and red wavelengths are eliminated near the surface. Much of the suspended material flocculated and settled within a day or more of standing in the laboratory. Floc patterns were also observed in the estuary from the air. Light transmission improves during the summer interval in direct proportion to the size of the algal crop, as measured by chlorophyll concentration. Circumstantial evidence indicates a self-clearing system which is based on co-flocculation of algae with clays and fine silts. The study suggests that a

clearer estuary is possible when inputs of algal nutrients and suspended solids are managed. (Author's abstract)
W90-04642

BACTERIOLOGICAL ASPECTS OF FLORIDA RED TIDES: A REVISIT AND NEWER OBSERVATIONS.

Connecticut Univ., Groton. Marine Sciences Inst. J. D. Buck, and R. H. Pierce.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 4, p 317-326, October 1989. 4 tab, 32 ref.

Descriptors: *Bacteria, *Toxins, *Red tide, *Marine bacteria, *Dinoflagellates, Aeromonas, Alteromonas, Pseudomonas, Vibrio, Florida, Gulf of Mexico, North Carolina, Fishkill.

Literature involving the occurrence of bacteria in red tides caused by the dinoflagellate *Ptychodiscus brevis* is briefly reviewed. Both quantitative and qualitative studies were made on outbreaks along the Florida Gulf coast in 1982 and 1987 and a bloom along the North Carolina coast in 1987. Non-bloom waters in both areas were sampled in 1988. Bacteria were also recovered from batch cultures of *P. brevis*. Bacterial isolates from red tide and normal waters and dinoflagellate cultures were tested for their ability to kill fish under laboratory conditions. Numbers of bacteria were always higher than reported for a 1971 outbreak but did not routinely correlate directly with *P. brevis* numbers. Storage of red tide water produced increased bacteria counts in some cases and decreased levels in another. Members of the genera *Aeromonas*, *Alteromonas*/*Pseudomonas*, and *Vibrio* were frequently isolated from the three blooms studied as well as from non-bloom waters; MPN (most probable number) of $> 1100/100$ ml of *Vibrio alginolyticus* were recorded from the non-bloom waters. Dominant chromogenic bacteria, reported during previous studies, were not observed in the samples. Several bacteria killed fish experimentally including isolates from red tide and normal waters and *P. brevis* cultures. It was concluded that a given dinoflagellate bloom is an individual event from a bacteriological standpoint, based on quantitative and qualitative comparison of historical observations and the present study. Recent reports of tetrodotoxin production by the isolated bacterial genera suggests a further consideration of bacteria in toxic dinoflagellate blooms. (Author's abstract)
W90-04643

PARTICLE-BORNE RADIONUCLIDES AS TRACERS FOR SEDIMENT IN THE SUSQUEHANNA RIVER AND CHESAPEAKE BAY.

Florida State Univ., Tallahassee. Dept. of Geology.
For primary bibliographic entry see Field 2J.
W90-04645

EXTRACELLULAR PROTEOLYTIC ENZYME ACTIVITY IN SEDIMENTS OF AN INTERTIDAL MUDFLAT.

Maine Univ., Walpole. Dept. of Oceanography. L. M. Mayer.
Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 973-981, September 1989. 9 fig, 31 ref. NSF Grant OCE87-00358 and ISP80-11448.

Descriptors: *Mud flats, *Intertidal areas, *Marine sediments, *Marine bacteria, *Enzymes, Proteases, Water depth, Temperature, Hydrogen ion concentration.

Extracellular proteolytic activity (EPA) on an intertidal mudflat was examined over a 2-yr period, with focus on characteristics of enzyme systems and the controlling influences on enzyme activity levels. EPA was primarily associated with the particulate rather than the pore-water phase. Inhibitor studies indicated the presence of primarily metallo and thiol proteases, with pH optima in the range 8-9.5. Temperature optima increased with depth in the sediment, being in the 20-35 °C range for surficial sediments and the 40-50 °C range in the subsurface. Activation energies at environmental

temperatures were in the 63-67 kJ/mol range. The hypothesis of progressive humification of enzyme activity with depth was discarded on the basis of results from thermal denaturation experiments. EPA levels decreased with depth and hence correlated with substrate concentration and bacterial populations, but this correlation was not a tight one. Seasonal variations in EPA varied with the temperature cycle consistent with, though somewhat damped relative to, the temperature dependence of the enzymes themselves and showed no response to variations in substrate concentrations or bacterial numbers. (Author's abstract)
W90-04648

FORMATION AND BACTERIAL UTILIZATION OF DISSOLVED ORGANIC CARBON DERIVED FROM DETRITAL LIGNOCELLULOSE.

Georgia Univ., Athens. Inst. of Ecology.
M. A. Moran, and R. E. Hodson.
Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 1034-1047, September 1989. 6 fig, 4 tab, 45 ref. NOAA NA80-AA-D00091; NSF OCE 87-18019 and BSR 88-06255.

Descriptors: *Wetlands, *Limnology, *Swamps, *Marshes, *Marsh plants, *Grasses, *Detritus, *Decomposition, *Lignocellulose, Salt marshes, Freshwater swamps, Mangrove swamps, Dissolved organic carbon, Decomposing organic matter, Bacterial utilization, Mineralization, Humic substances.

In various wetland ecosystems, lignocellulose from aquatic vascular plants is the most abundant reservoir of organic material. During microbial degradation of lignocellulose, soluble decomposition products are released into the environment. The importance of lignocellulose-derived dissolved organic carbon (LC-DOC) to ecological and geochemical processes depends on the rate of formation of these compounds and their subsequent fates. In laboratory microcosms, rates of formation of LC-DOC for pools formed at 1, 2, 7, and 13 weeks into decomposition indicated that soluble intermediates produced throughout the first 3 months of lignocellulose degradation, although gradually decreasing in amount, were of similar composition. Bacterial mineralization of each pool was initially very rapid (12% in 16 h), indicating the presence of labile compounds in LC-DOC. Rates slowed after the first day, however, resulting in mineralization of 30% of the original pool after 30 d. LC-DOC formation and its subsequent bacterial utilization were also documented for the dominant vascular plant in two other aquatic ecosystems—a freshwater swamp and a mangrove swamp. Up to 40% of total lignocellulose mineralization in these marine and freshwater systems can be traced to use of LC-DOC by both free-living and attached bacteria. However, some components of LC-DOC, presumably those compounds recalcitrant to microbial action, accumulated during lignocellulose decomposition. This unused LC-DOC may play a role in the formation of humic substances in wetland environments or other aquatic ecosystems with substantial inputs of vascular plant detritus. (Author's abstract)
W90-04651

DIFFUSION METHODS FOR THE DETERMINATION OF REDUCED INORGANIC SULFUR SPECIES IN SEDIMENTS.

Florida Agricultural and Mechanical Univ., Tallahassee. Div. of Agricultural Science.
For primary bibliographic entry see Field 7B.
W90-04654

CLAM BURROWING BIOASSAY FOR ESTUARINE SEDIMENT.

District of Columbia Univ., Washington. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-04677

TIDAL EFFECT ON NUTRIENT EXCHANGE IN XIANGSHAN BAY, CHINA.

National Bureau of Oceanography, Hangzhou

Field 2—WATER CYCLE

Group 2L—Estuaries

(China). Second Inst. of Oceanography.
F. Ande, and J. Xisan.
Marine Chemistry MRCHBD, Vol. 27, No. 3-4, p 259-281, October 1989. 7 fig, 4 tab, 20 ref.

Descriptors: *Estuaries, *China, *Tidal effects, *Cycling nutrients, Eutrophication, Nitrates, Ammonium, Bottom water, Coastal waters, Spring tides, Neap tides, Phosphates, Silicates, Storm tides.

Xiangshan Bay is an estuary in China which borders on the east China Sea. The circulation in the estuary is driven by tidal movement, residual current, the internal density distribution, and synoptic wind forcing; however, the last three are not the main dynamic factors affecting nutrient transport. Because the estuary tends to be eutrophic, a synoptic study was carried out to assess the influence of tidal movement on the nutrient distribution patterns within the estuary and to estimate the fluxes of nutrient transport between the estuary and the sea. Nitrate and ammonium are found to be exported from the estuarine water to the coastal water under usual tidal conditions, except for storm tides which result in large amounts being imported because of the extremely high concentrations in the coastal bottom water. Exports of phosphate and silicate are shown to be consistent during spring tides and neap tides in all seasons. However, the usual tidal regimes resulted in only minor nutrient exchange except during abnormal events. (Author's abstract)

W90-04701

SUSPENDED MATTER IN THE SOUTH YELLOW SEA.

Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 2J.
W90-04720

TIDAL MODELLING OF DAPENG BAY, CHINA.

Zhongsan Univ., Guangzhou (China).
X. Zhan.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 2, p 149-155, 1989. 5 fig, 1 tab, 5 ref.

Descriptors: *Tides, *Bays, *Model studies, *China, *Tidal currents, Hydrodynamics, Finite difference methods, Computer programs.

A two-dimensional finite difference alternating direction implicit (ADI) scheme numerical model to solve the vertically integrated form of the non-linear hydrodynamic equations has been developed for description of tide flow in Dapeng Bay, China. Computer software for the modeling is well designed to reduce storage and costs of computation. The computed results agree quite well with the observations available. Tidal flow characteristics, including water level, tidal current, and residual current, are discussed based on the computed results and observed data. When the strongest flood tidal currents occur in Dapeng Bay, A large counter-clockwise eddy forms with the velocity of 10-30 cm/s; however, when the strongest ebb tidal currents occur, a large clockwise eddy forms with the velocity of 10-30 cm/s. Two strong residual current eddies are observed in the southern part of the modeled domain and no residual current eddy is observed in the northern part of the Dapeng Bay. (Author's abstract)

W90-04722

SULFIDE TOLERANCE AND DETOXIFICATION IN SHALLOW-WATER MARINE FISHES.

Scriptis Institution of Oceanography, La Jolla, CA. Marine Biology Research Div.
T. Bagarinao, and R. D. Vetter.
Marine Biology MBIOAJ, Vol. 103, No. 3, p 291-302, 1989. 3 fig, 6 tab, 42 ref.

Descriptors: *Sulfides, *Water quality, *Water pollution effects, *Toxicity, *Fish, *Coastal waters, Fish physiology, Tolerance, Detoxification, Ecological distribution.

Hydrogen sulfide is a potent inhibitor of aerobic respiration. Sulfide is produced in sediments, and many species of fish live in association with the bottom. Tolerance tests, enzyme assays, and chromatography of sulfur compounds in thirteen species of shallow-water marine fishes (collected in San Diego, California, in 1987-1988) indicate adaptations to sulfide that vary with habitat and life-style. Tidal-marsh inhabitants, like *Gillichthys mirabilis* and *Fundulus parvipinnis*, have higher tolerance to sulfide (96 h LC50 at 525 to 700 μ M) relative to outer-bay and open-coast inhabitants (surviving <12 h at much lower concentrations). The cytochrome c oxidase of all species shows high activity and susceptibility to sulfide poisoning, with 50% inhibition at 30 to 500 nM in various tissues. The two marsh species are able to survive at sulfide concentrations already inhibitory to their cytochrome c oxidase and fatal to other species. All species detoxify sulfide by oxidizing it to thiosulfate. All have sulfide-oxidizing activity in the blood, spleen, kidney, liver and gills, which correlates significantly with heme content. Thiosulfate appears in the tissues of sulfide-exposed fish and builds up to high concentrations (up to 2mM) with stronger and longer exposure. Unexposed fish contain little or no thiosulfate. Sulfide is barely detectable in the tissues, even in high-sulfide exposure tests. We suggest that fish blood, in having high sulfide-oxidizing activity and no cytochrome c oxidase, can act as a short-term first line of defense against sulfide, and thus minimize the amount that reaches the vital organs. The results of this study indicate that sulfide is a significant environmental factor influencing the ecological distribution of marine fishes. (Author's abstract)

W90-04726

PATHWAYS OF ARSENIC UPTAKE AND INCORPORATION IN ESTUARINE PHYTOPLANKTON AND THE FILTER-FEEDING INVERTEBRATES EURYTEMORA AFFINIS, BALANUS IMPROVISUS AND CRASSOSTREA VIRGINICA.

Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.
W90-04727

APPARATUS FOR MONITORING AND CONTROLLING TURBIDITY IN BIOLOGICAL EXPERIMENTS.

Delaware Univ., Newark. Coll. of Marine Studies.
For primary bibliographic entry see Field 7B.
W90-04728

RUPPIA CIRRHOSA: DECOMPOSITION IN A COASTAL TEMPERATE LAGOON AS AFFECTED BY MACROINVERTEBRATES.

Barcelona Univ. (Spain). Dept. de Ecologia.
M. Menendez, E. Fores, and F. A. Comin.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 39-48, November 1989. 3 fig, 3 tab, 26 ref.
Caixa de Barcelona, CICYT (PAC84-16-C02-02) and EEC (EV4V-0132-L).

Descriptors: *Sea grasses, *Coastal waters, *Temperate zone, *Bays, *Submerged plants, *Lagoons, *Macroinvertebrates, *Grazing, *Detritus, *Decomposing organic matter, *Decomposition, Carbon, Nitrogen, Phosphorus, Ruppia, Ebro Delta, Spain.

The decomposition process of *Ruppia cirrhosa* was studied in a Mediterranean coastal lagoon in the Delta of the River Ebro (NE Spain). Leaves and shoots of *Ruppia* enclosed in litter bags were collected in the lagoon at the end of the growing season. Litter bags 100 microns and 1 mm meshes were used to ascertain the effects of macroinvertebrates, that were able to enter only into the latter litter bags, on the process of decay. Macroinvertebrate species found in the 1 mm-mesh bags were *Gammarus aquacade* and *Sphaeroma hookeri*. Significant differences were observed between the decomposition processes in the two bag types. No detritus remained in the 1 mm-mesh bags after 180 days, and 360 days were required for the same loss in the 100 micron-mesh bags. Decomposition rates according to the exponential model in the 100

micron-, and the 1 mm-mesh bags are 0.0037/day and 0.0048/day, respectively. The observed decomposition in the 100 micron-mesh bags is better correlated ($r=0.83$) with the exponential model than the decomposition process in the 1 mm-mesh bags ($r=0.61$). Grazing by invertebrates is a major factor responsible for this difference. Rates of decomposition are higher during the initial three days of the experiment. Carbon, nitrogen, and phosphorus losses are similar to dry weight loss within the same periods between samplings of the decomposition process. The results are compared with data from the literature about the decomposition processes of plant species over a range of structural components and environmental conditions. (Author's abstract)

W90-04806

LONG-TERM STATISTICAL CHARACTERISTICS OF SEVERAL PHYSICO-CHEMICAL PARAMETERS OF THE NEARSHORE WATERS IN THE CONSTANTA ZONE.

Institutul Roman de Cercetari Marine, Constanta (Romania).

A. Popa, A. Cociasu, L. Popa, I. Voinescu, and L. Dorogan.

Cercetari Marine: Recherches Marines, Vol. 18, p 7-51, 1985. 18 fig, 19 tab, 2 ref.

Descriptors: *Black Sea, *Water chemistry, *Romania, Physicochemical properties, Time series analysis, Temperature, Salinity, Dissolved oxygen, Organic matter, Silicates, Phosphates, Data interpretation.

A chronological data series was collected daily for sea water temperature, salinity, oxygen, organic matter, nitrate, silicate, and phosphate at the Constanta shore station (Black Sea) from 1959-1983. Frequency distributions were calculated and the quarterly, seasonal, and semestral patterns analyzed. The following observations were made: (1) water temperature exhibits a clear annual cycle; (2) the standard deviation for salinity data for the spring was twice that for the summer data and four times that of the autumn data; (3) oxygen content exhibits an annual cycle, with high mean values in winter, but also a high standard deviation; (4) organic matter exhibits a pronounced modal frequency; (5) the annual nitrate cycle has a large amplitude with a mean winter value about four times greater than the summer value; (6) the silicate content, as well as the phosphate content, shows a considerable variation in time due to the modification of environmental conditions; and (7) phosphate concentration statistics showed a more spectacular increase in the mean monthly averages during 1970-1975 (10-38 times higher than those of the previous period). (White-Reimer-PTT)

W90-04853

PROBLEMS CONCERNING MARINE EUTROPHICATION, (PROBLEMS CONCERNANT L'EUTROPHISATION MARINE).

Institutul Roman de Cercetari Marine, Constanta (Romania).

For primary bibliographic entry see Field 5C.
W90-04854

DISTRIBUTION OF CHLOROPHYLL A, PHAEOPHYTIN A AND PRIMARY PRODUCTION IN THE WESTERN BLACK SEA.

Institutul Roman de Cercetari Marine, Constanta (Romania).

A. S. Bologa, Z. P. Burlakova, V. D. Tchmyr, and V. I. Kholodov.

Cercetari Marine: Recherches Marines, Vol. 18, p 97-115, 1985. 4 fig, 5 tab, 18 ref.

Descriptors: *Water pollution effects, *Black Sea, *Romania, *Eutrophication, *Chlorophyll, Primary productivity, Phaeophytin, Algal blooms, Correlation analysis.

High values of chlorophyll a concentrations and primary production were found in the predanubian sector as compared to the Caliacra and prebosporic sectors in the western part of the Black Sea. In the predanubian sector the chlorophyll a con-

centration and primary production values were higher nearshore than in the open sea. The high values of chlorophyll *a* and of primary production in the preanubian sector, which are much higher than those of the last two decades, are due to the very strong eutrophication of the northwestern part of the Black Sea as a result of the nutrients from the Danube and the consequent occurrence of intense phytoplankton blooms. The highest values in the preanubian sector in May 1982, were 35 mg/cu m for the chlorophyll *a* concentration, 34 mg/cu m for the phaeophytin *a* concentration, and 1.5 g C/cu m/d and 1.6 g C/cu m/d for the primary production. In the preanubian sector, in contrast to the other two southern sectors, maximum primary production with depth was determined only for the upper layer between 0 to 5 m. For the prebospic, Caliacra and preanubian sectors the highest assimilation numbers reached 12.5, 7.0 and 5.3 mg C/mg chl *a*/h, respectively. By means of factorial analysis, very high correlation coefficients were established between chlorophyll *a* concentration and salinity (-0.91), between primary production and salinity (-0.94) and between chlorophyll *a* concentration and primary production (0.91). (White-Reimer-PTT) W90-04855

CHARACTERISTICS OF THE QUANTITATIVE DEVELOPMENT AND THE STRUCTURE OF THE PHYTOPLANKTON ON THE ROMANIAN SHORE FROM 1983-1985. (CARACTERISTIQUE DU DEVELOPEMENT QUANTITATIF ET DE LA STRUCTURE DU PHYTOPLANKTON DES EAUX DU LITTORAL ROUMAIN PENDANT LA PERIODE 1983-1985).

Institutul Roman de Cercetari Marine, Constanta (Romania).
N. Bodeanu.
Cercetari Marine: Recherches Marines, Vol. 18, p 117-137, 1985. 3 fig, 5 tab, 13 ref. English summary.

Descriptors: *Romania, *Water pollution effects, *Black Sea, *Eutrophication, *Phytoplankton, Algal blooms, Dinoflagellates, Diatoms, Nutrients.

Based on research carried out along the coast from Sulina to Constanta from 1983 to 1985, the quantitative characteristics and community structure of the phytoplankton along the Romanian shore are correlated with the eutrophication process. Following the period of eutrophication during the 1970's, the total phytoplankton has declined (with a corresponding reduction in the nutrient supply), algal blooms have decreased, and the heavily dominant species have decreased (while the number of less abundant species has increased). The quantitative changes in the algal community in the 1983-1985 period and the decrease in dinoflagellate blooms are also reflected by the reduction of dinoflagellates in general and an increase in diatoms. (Author's abstract) W90-04856

PHYTOPLANKTON DIVERSITY INDICES AS EUTROPHICATION INDICATORS OF THE ROMANIAN INSHORE WATERS.

Institutul Roman de Cercetari Marine, Constanta (Romania).
For primary bibliographic entry see Field 5C. W90-04857

ICHTHYOPLANKTON INTERCHANGE IN THE MOUTH REGION OF A SOUTHERN AFRICAN ESTUARY.

J.L.B. Smith Inst. of Ichthyology, Grahamstown (South Africa).
A. K. Whitfield.
Marine Ecology Progress Series MESED, Vol. 54, No. 1-2, p 25-33, June 1989. 7 fig, 1 tab, 36 ref.

Descriptors: *Estuaries, *Fish populations, *South Africa, *Plankton, Ichthyoplankton, Seasonal variation, Diurnal variation, Model studies, Larvae, Water currents, Tides.

Migration patterns of ichthyoplankton in the seasonally open Swartvlei estuary were monitored during 1986/87 with particular emphasis on ex-

change between the estuary and sea. Four groups of fishes are recognized in the area according to breeding and recruitment strategies. Group 1 consists of species (e.g. *Rhabdosargus holube* and *Monadactylus falciformis*) which spawn at sea, enter the estuary mainly as postlarvae, and congregate along the margins or on the bottom where water current speeds are reduced. Group 2 species (e.g. *Spondyliosoma emarginatum* and *Etrumeus whiteheadi*) also spawn at sea, their larvae are swept into the estuary on the flood tide, but are returned to the marine environment on the ebb tide. Breeding and larval development of Group 3 species (e.g. *Hippocampus capensis* and *Syngnathus acus*) occur within the estuary, although some eggs and larvae are lost to the sea following opening of the mouth. Group 4 larvae (e.g. *Psammogobius knysnaensis* and *Caffrogobius* spp.), which hatch from demersal eggs in the estuary, leave the system on the ebb tide before returning several weeks later as postlarvae. Diel ichthyoplankton density changes in the lower reaches of the Swartvlei estuary revealed that movements of larvae and postlarvae between the estuary and marine environment occurred mainly during twilight/nocturnal hours. The above data, together with a hydrodynamic model of the estuary, has enabled the quantification of ichthyoplankton exchange over specific 24 h periods. (Author's abstract) W90-04868

COMPARISON OF SINKING AND SEDIMENTATION RATE MEASUREMENTS IN A DIATOM WINTER/SPRING BLOOM.

Rhode Island Univ., Narragansett. Graduate School of Oceanography.
U. Riebesell.
Marine Ecology Progress Series MESED, Vol. 54, No. 1-2, p 109-119, June 1989. 8 fig, 2 tab, 71 ref.

Descriptors: *Estuaries, *Phytoplankton, *Diatoms, *Algal blooms, *Sedimentation rates, Sinking rate, Seasonal variation, Biomass.

Sinking and sedimentation rates of a natural phytoplankton community were simultaneously measured during the course of a diatom winter/spring bloom in a 13 cu m experimental mesocosm. Sinking rate was determined directly in settling columns and was calculated from sediment trap catches. The 2 methods yielded significantly different results. Whole-community as well as species specific sinking rates varied over time. These variations were related to changes of the environmental conditions. Over a 26 d study period, a total of 7.5 g C/sq m was collected in the sediment traps. Viable phytoplankton cells were the primary component of the sedimented matter while zooplankton fecal pellets contributed on average less than 10%. Assuming the Redfield atomic ratio for the collected material, the amount of carbon which sedimented during the winter/spring bloom could be predicted from pre-bloom nutrient concentrations. The daily sedimentation rate varied considerably over time and displayed a characteristic pattern. This pattern is evidently a function of both suspended phytoplankton biomass and the temporal variation in whole-community sinking rate. (Author's abstract) W90-04870

ORGANIC CARBON FLUX THROUGH A DELAWARE BAY SALT MARSH: TIDAL EXCHANGE, PARTICLE SIZE DISTRIBUTION, AND STORMS.

Delaware Univ., Newark. Coll. of Marine Studies.
C. T. Roman, and F. C. Daiber.
Marine Ecology Progress Series MESED, Vol. 54, No. 1-2, p 149-156, June 1989. 2 fig, 6 tab, 36 ref.

Descriptors: *Organic carbon, *Delaware Bay, *Salt marshes, *Tides, *Nutrients, Particulate matter, Storms, Dissolved organic carbon, Detritus, Flooding, Carbon exchange budget, Seasonal variation.

Organic carbon exchange via tidal transport between a 190 ha *Spartina alterniflora* marsh and

Delaware Bay was quantified during 5 seasonal sampling periods in 1980-81. Based on hourly samples collected over 3 consecutive tidal cycles, mean ebb tide concentrations of particulate organic carbon (POC) were higher than flood tide concentration, except in January when the marsh surface and creeks were frozen. Mean ebb tide dissolved organic carbon (DOC) concentrations were greater than flood during all seasons. The relative degree of marsh surface flooding, current velocity and phytoplankton concentration are important factors influencing seasonal differences in mean flood and mean ebb concentrations of POC. A broad size spectrum of particulate detritus is available to estuarine consumers, with 60 to 84% of the total POC on both flood and ebb tides being < 20 microm in size and the remaining material distributed fairly equally among larger fractions. There was a net export of POC from Canary Creek marsh during all seasonal studies, except in January when exchange processes were much reduced. DOC was exported during all studies, except in June when the water volume transport estimate was significantly biased toward the flood direction. Annually, 105,000 kg was exported as POC and 197,000 kg as DOC. The influence of storms was not included in the annual organic carbon exchange budget. However, during an October tropical storm ebb-directed transports of POC and DOC were 5 to 6 times greater than during the normal ebb cycles monitored in October, suggesting that major coastal storms are significant to salt marsh organic material exchange processes. Elevated POC concentrations during 2 ebb cycles following and intense rainstorm in April suggest that these episodic events also represent important marsh-estuarine exchange mechanisms. (Author's abstract) W90-04871

STABLE ISOTOPE RATIOS AND CONTAMINANT CONCENTRATIONS IN A SEWAGE-DISTORTED FOOD WEB.

Lawrence Livermore National Lab., CA. Environmental Sciences Div.
For primary bibliographic entry see Field 5B. W90-04872

DIFFERENCES IN PHYTOPLANKTON ABUNDANCE AND DISTRIBUTION BETWEEN THE ABRA OF BILBAO AND THE ADJACENT SHELF WATERS.

Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
E. Orive.
Hydrobiologia HYDRB8, Vol. 182, No. 2, p 121-135, 1989. 12 fig, 1 tab, 34 ref.

Descriptors: *Coastal environment, *Phytoplankton, *Marine algae, Dinoflagellates, Diatoms, Spatial distribution, Seasonal variation, Spain.

Phytoplankton spatial distribution patterns in the Abra of Bilbao (a semienclosed coastal body of water) and adjacent shelf waters have been studied during June-July 1983 and May-June 1984. Small naked dinoflagellates, cryptophytes and an unidentified nanoplankton component, were a common feature in all surveys. In July 1983 a dense bloom of nanoplankton developed inside the Abra which, in contrast to the community in the adjacent waters, contained high densities of small diatoms, naked dinoflagellates, cryptophytes and the Haptophyta, *Phaeocystis pouchetii*. Microplankton was mainly composed of dinoflagellates in July 1983, and of diatoms in June 1983 and May-June 1984. Microplankton abundance was highest in May-June 1984 and decreased from the shelf to the Abra. A principal component analysis performed separately on each cruise revealed the differences in the structure of the phytoplankton community between the abra of Bilbao and the adjacent shelf waters. (Author's abstract) W90-04891

ECONOMIC BENEFITS OF HABITAT RESTORATION: SEAGRASS AND THE VIRGINIA HARD-SHELL BLUE CRAB FISHERY.

Old Dominion Univ., Norfolk, VA. Dept. of Eco-

Field 2—WATER CYCLE

Group 21—Estuaries

nomics.

E. A. Anderson.
North American Journal of Fisheries Management
NAJMDP, Vol. 9, No. 2, p 140-149, Spring 1989. 5
fig, 5 tab, 16 ref.

Descriptors: *Estuarine fisheries, *Habitat restoration, *Economic aspects, *Crabs, *Sea grasses, *Virginia, Benefits, Water pollution effects, Submerged plants, Revegetation, Simulation analysis, Model studies, Chesapeake Bay.

Since the early 1960s, water pollution has caused the disappearance of much of the seagrass (predominantly eelgrass *Zostera marina*) and other submerged aquatic vegetation in Chesapeake Bay. Seagrass beds appear to serve as preferred habitat for the blue crab *Callinectes sapidus* during early stages of its life history, and there is a statistically significant relationship between the abundance of submerged aquatic vegetation and catch per unit of effort in the Virginia hard-shell blue crab fishery. Virginia seagrass beds might be partially or fully restored through a combination of pollution abatement and replanting. A simple simulation model with minimal data requirements to generate rough estimates of some of the economic benefits that would accrue from seagrass restoration was developed. The estimated net economic benefit to Virginia hard-shell blue crab fishermen of full seagrass restoration is about \$1.8 million per year, and additional annual benefits of about \$2.4 million should accrue to United States hard-shell blue crab consumers. (Author's abstract)
W90-04914

EFFECTS OF COOLING WATER DISCHARGE ON THE STRUCTURE AND DYNAMICS OF EPIPLITHIC ALGAL COMMUNITIES IN THE NORTHERN BALTIC.

Uppsala Univ. (Sweden). Inst. of Ecological Botany.
For primary bibliographic entry see Field 5C.
W90-04960

DISTRIBUTION AND IMPORTANCE OF AUTOTROPHIC ULTRAPLANKTON IN A BOREAL INSHORE AREA (KIEL BIGHT, WESTERN BALTIC).

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
F. Jochem.
Marine Ecology Progress Series MESED, Vol. 53, No. 2, p 153-168, 1989. 9 fig, 2 tab, 43 ref.

Descriptors: *Phytoplankton, *Coastal waters, *Baltic Sea, Ultraplankton, Chlorophyll a, Primary productivity, Biomass, Seasonal variation, Vertical distribution, Water temperature, Salinity, Kiel Bight, Kiel Fjord.

From April to October 1986, 4 stations in Kiel Bight and Kiel Fjord (Western Baltic) were investigated twice each month for the distribution and importance of autotrophic ultraplankton (<20 micron) by size-fractionated records of chlorophyll a and primary productivity within the size classes micro (> 20 micron), nano (3-20 micron) and picoplankton (<3 micron). Their development was compared with the physical environment in terms of salinity and temperature profiles and nutrient concentrations. Except the diatom-dominated spring bloom and the autumn dinoflagellate bloom, ultraplankton contributed 70-100% of phytoplankton biomass and productivity. The change from new production by microplankton in spring to the ammonia-maintained, mainly regenerated production in summer and again to new production by microplanktonic dinoflagellates in autumn was characterized by a nanoflagellate bloom. In May, this bloom was built up by the non-skeletforming form of the silicoflagellate *Dictyocha fibula*. In September, *Prorocentrum minimum* bloomed. In between, nanoplankton was the overall dominating size fraction. Picoplankton attained its greatest importance in mid-summer, contributing 8-33% of total phytoplankton chlorophyll and production. Whereas absolute biomass and productivity of picoplankton, as well as of all other size classes, decreased towards the less eutrophic open Kiel Bight, picoplankton contribution to total phyto-

plankton biomass and production increased in this direction. Nanoplankton contribution increased towards the eutrophic inner Kiel Fjord. Pycnoclines and nutriclines supported both ultraplankton productivity and the structure of their vertical distribution. If the pycnoclines were strong, however, picoplankton seemed unable to pass through it. There were indications of pronounced diurnal vertical migration of the nanoflagellates *P. minimum* and *D. fibula*. (Author's abstract)
W90-04977

BACTERIAL PRODUCTION IN THE RHONE RIVER PLUME: EFFECT OF MIXING ON RELATIONSHIPS AMONG MICROBIAL ASSEMBLAGES.

Delaware Univ., Lewes. Coll. of Marine Studies.
D. Kirchman, Y. Soto, F. Van Wambeek, and M. Bianchi.
Marine Ecology Progress Series MESED, Vol. 53, No. 3, p 267-275, 1989. 7 fig, 3 tab, 30 ref. NSF grant OCE 8614170.

Descriptors: *Aquatic bacteria, *Phytoplankton, *Rivers, *Primary productivity, *Nutrients, Ammonium, Nitrates, Phosphates, Plumes, Chlorophyll, Biomass, Salinity, Rhone River, Mediterranean Sea.

Inorganic nutrients and microbial assemblages in the Rhone River plume were examined during January 1987. When wind speed is low the plume forms a transient layer of high nutrient-low salinity water overlaying the Mediterranean Sea, which has very low nutrient concentrations. The vertical thickness of the plume was on the order of 100 cm, and during one horizontal transect surface density decreased 2-fold within 1 km. Ammonium, nitrate, and phosphate concentrations were at least 10-fold higher in the thin plume compared with Sea values. Bacterial production (thymidine and leucine incorporation) was higher by about 2-fold at plume-sea boundaries. Although bacterial biomass and production peaked with chlorophyll at plume-sea boundaries, the correlation between these bacterial parameters and chlorophyll concentrations was low. The ratio of bacterial biomass to phytoplankton biomass was greater than 1 for low salinity waters. The results suggest that microbial loop relationships had been disrupted in the Rhone River plume because of the input of allochthonous carbon and because of rapid changes in growth conditions caused by mixing. In addition to affecting physicochemical parameters, mixing appears to have diluted heterotrophic flagellate abundance which allowed increases in autotrophic abundance and bacterial production. (Author's abstract)
W90-04979

CHANGES IN COPPER-COMPLEXING ORGANIC LIGANDS DURING SPRING BLOOMS IN THE COASTAL WATERS OF NOVA SCOTIA, CANADA.

Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
X. Zhou, and P. J. Wangersky.
Marine Ecology Progress Series MESED, Vol. 53, No. 3, p 277-284, 1989. 5 fig, 1 tab, 18 ref.

Descriptors: *Metal complexes, *Canada, *Phytoplankton, *Algal blooms, *Coastal waters, *Organic compounds, *Copper, Nova Scotia, Chromatography, Spectrophotometry.

Copper-complexing organic ligands were produced by actively-growing phytoplankton during spring blooms in Bedford Basin and the Northwest Arm, Halifax, Nova Scotia. Ionoscan thin layer chromatography/flame ionization detector and thin layer chromatography/atomic absorption spectrophotometry analysis showed the naturally occurring ligands to be qualitatively similar to those produced by phytoplankton grown in batch and continuous culture. The Bedford Basin bloom was interrupted by an extremely heavy rainfall, resulting in a large contribution of material, including organic ligands, from terrestrial sources. The ligand contributed from this source could be shown to be qualitatively different from that produced in situ by bloom organisms. (Author's abstract)

W90-04980

SIMULTANEOUS MEASUREMENT OF BACTERIOPLANKTON PRODUCTION AND PROTOZOAN BACTERIVORY IN ESTUARINE WATER.

Georgia Univ., Sapelo Island. Marine Inst.
B. F. Sherr, E. B. Sherr, and C. Pedros-Alio.
Marine Ecology Progress Series MESED, Vol. 54, No. 3, p 209-219, 1989. 2 fig, 4 tab, 61 ref. NSF grant OCE-8700456.

Descriptors: *Estuaries, *Aquatic bacteria, *Bacterioplankton, *Protozoa, Grazing, Salt marshes, Tidal creeks, Sapelo Island, Georgia.

Simultaneous measurements were made of bacterioplankton productivity (tritiated thymidine assay) and of bacterial mortality due to protozoan grazing (measured via uptake of fluorescently labeled bacterioplankton, FLB). Water samples were taken from a salt marsh tidal creek and from an estuarine sound near Sapelo Island, Georgia, at low tide over a 2-wk period in late summer. In control experiments performed to test the extent of selectivity of estuarine bacterivorous protozoa for or against FLB compared to natural bacterioplankton, no evidence was found for consistent discrimination. Rates of bacterial production and of protozoan bacterivory were greater in the tidal creek than in the open sound. Ciliates were responsible for the largest fraction of total protozoan consumption of bacteria in tidal creek water and colorless flagellates in open estuary water. Bacterial production and protozoan bacterivory were not always in balance in individual samples, with the largest discrepancies in the open estuary. Estimated bacterivory was, on average, 80% of bacterial production in the tidal creek and 50% of production in the open estuary. Explanations for the measured shortfall in bacterial mortality include methodological problems with the assays used or alternate fates of bacterial production besides protozoan grazing. (Author's abstract)
W90-04981

ALGAE ASSOCIATED WITH MANGROVES IN SOUTHERN AFRICAN ESTUARIES: CYANOPHYCEAE.

Natal Univ., Durban (South Africa). Oceanographic Research Inst.
G. Lambert, T. D. Steinke, and Y. Naidoo.
South African Journal of Botany SAJBDD, Vol. 55, No. 5, p 476-491, October, 1989. 28 fig, 3 tab, 65 ref.

Descriptors: *Cyanophyta, *Estuaries, *Mangrove swamps, Species composition, South Africa, Nitrogen, Habitats.

Taxa of the Class Cyanophyceae which are inconspicuous within a turf-like *Bostrychium* that coats plant, mud and rock in the mangrove-associated estuaries of southern Africa were identified. The pneumatophores of the white mangrove *Avicennia marina* support the richest flora. Of the 27 taxa recorded *Microcoleus chthonoplastes* has the widest biogeographical range and was common on most substrata. Non-heterocystous were more prevalent than heterocystous Cyanophyceae and four other taxa occurred epiphytically on the dominant macroalgal species of *Bostrychia*, *Caloglossa*, *Enteromorpha* and *Rhizoclonium*. Epipellic mats were intricately interwoven with sediment and filamentous greens and blue-greens, particularly *Microcoleus chthonoplastes* and the green algae *Rhizoclonium* spp. As they occur in most estuaries, these taxa may play an important role in sediment stabilization. Active nitrogenase activity in pure cultures of *Microcoleus chthonoplastes*, a dominant mangrove associate with a thick sheath has been confirmed. Perhaps this species also fixes nitrogen aerophilically, then its prevalence suggests strongly that it might play a significant role as a source of nitrogen in southern African mangrove swamp ecosystems. (Author's abstract)
W90-04993

PHYTOPLANKTON FLUCTUATIONS DURING AN ANNUAL CYCLE IN THE COASTAL LAGOON OF CULLERA (SPAIN). Valencia Univ. (Spain). Dept. of Ecology. C. Rojo, and M. R. Mirale. *Internationale Revue der Gesamten Hydrobiologie IGHYAZ*, Vol. 74, No. 2, p. 179-194, 1989. 5 fig, 3 tab, 16 ref.

Descriptors: *Estuaries, *Phytoplankton, *Spain, *Algae, *Coastal lagoons, Salinity, Seasonal variation, Vertical distribution, Oxygen, Stratification.

The seasonal variation and the vertical distribution of the phytoplankton population of the lagoon of Cullera, an elongated coastal lagoon with estuarine circulation of water, has been studied in three sampling stations: mouth, center and source. Seasonal variation is determined by a marine-freshwater interaction. In winter, the sea influence is important, a marine water wedge of anoxic water arrives at the sampling station located at the source, and marine and brackish water species dominate the phytoplankton. Also marine species of zooplankton and fish enter the system, which may then be considered as exploited by the sea. In spring the marine wedge retreats from the source but remains in the center and mouth, salinity diminishes, vertical mixing persists and phytoplankton is dominated by *Cyclotella* species. From late spring to autumn the freshwater influence prevails and a sharp stratification of the water is produced in the stations at the mouth and the center, by means of a steep halocline coincident with an oxycline. The phytoplankton in this period follows a typical succession like those described in freshwater eutrophic lakes. Vertical distribution of phytoplankton is determined by the presence of the oxycline, originated by the marine water wedge, whose depth varies seasonally but which is always present in the mouth and center of the lagoon; only a few species of algae can be found below its level. (Author's abstract)

W90-05049

VERTICALLY AVERAGED SPECTRAL MODEL FOR TIDAL CIRCULATION IN ESTUARIES: PART 1. MODEL FORMULATION. Geological Survey, Sacramento, CA. Water Resources Div. J. R. Burau, and R. T. Cheng. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4126, April 1989. 32p, 6 fig, 41 ref.

Descriptors: *Tidal currents, *Tides, *Estuaries, *Mathematical models, Shallow-water equations, Harmonic analysis, Spectral models, Finite element method.

A frequency dependent computer model based on the two-dimensional vertically averaged shallow-water equations is described for general purpose application in tidally dominated embayments. This model simulates the response of both tides and tidal currents to user-specified geometries and boundary conditions. The mathematical formulation and practical application of the model are discussed in detail. Salient features of the model include the ability to specify: (1) stage at the open boundaries as well as within the model grid, (2) velocities on open boundaries (river inflows and so forth), (3) spatially variable wind stress, and (4) spatially variable bottom friction. Using harmonically analyzed field data as boundary conditions, this model can be used to make real time predictions of tides and tidal currents. (USGS)

W90-05193

FLOW AND HYDRAULIC CHARACTERISTICS OF THE KNIK-MATANUSKA RIVER ESTUARY, COOK INLET, SOUTHCENTRAL ALASKA. Geological Survey, Anchorage, AK. Water Resources Div. S. W. Lipscomb.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4064, 1989. 52p, 29 fig, 6 tab, 8 ref.

Descriptors: *Estuaries, *Bridge design, *Tides, *Unsteady flow, Flow velocity, Model studies, Floods, Flood peak.

A study of the riverine-estuarine reach of the Knik and Matanuska Rivers provided flow and hydraulic data for use in the design of additional bridges over the rivers. Hydraulic analysis is complicated because: (1) the lower reaches of the rivers merge in a complex system of interconnected channels; and (2) this reach is subject to unsteady flow conditions resulting from a semidiurnal tide wave propagated up the channel through Knik Arm from Cook Inlet, whose tidal range is among the largest in the world. Analysis of flows for the Knik River is further complicated by the historic formation and outburst flooding of glacier-dammed Lake George in the Upper Knik River basin. Peak flows on the Knik River due to breakout floods were as much as seven times greater than peak flows of non-breakout floods. The U.S. Geological Survey's branch-network flow model was used to simulate flows within the study reach. For the Knik River, simulated flows were within 10% of measured values in most cases. The model was also used to simulate the flow, stage, and velocity that would be expected in the various channels under different bridge configurations. (USGS)

W90-05215

EFFECTS OF SULFIDE ON THE GROWTH OF THREE SALT MARSH HALOPHYTES OF THE SOUTHEASTERN UNITED STATES.

Georgia Inst. of Tech., Atlanta. School of Applied Biology. P. M. Bradley, and E. L. Dunn. *American Journal of Botany* AJBOAA, Vol. 76, No. 12, p. 1707-1713, December 1989. 2 fig, 3 tab, 35 ref.

Descriptors: *Salt marshes, *Marsh plants, *Coastal marshes, *Sulfides, Hydroponic cultures, *Spartina*, *United States*, *Borrichia*, Growth, Productivity.

A hydroponic culture experiment was performed to ascertain whether sediment soluble sulfide at in situ concentrations plays a role in the determination of height forms of *Spartina alterniflora* in salt marshes of the United States. Additional experiments were conducted for both *Spartina cynosuroides* and *Borrichia frutescens* to determine if sulfide also influences the overall distribution of these species in the marsh. In situ soluble sulfide concentrations ranged from 0.02 mM in creek bank sites up to 3.0 mM in the inner marsh. In culture treatments, both plant height and biomass production of *S. alterniflora* were inhibited at a sulfide concentration as low as 1.0 mM, strongly suggesting a role for sulfide in the determination of height forms in the marsh. Production of *S. cynosuroides* was inhibited at high sulfide concentrations. However, over a range of concentrations similar to in situ values, no significant reduction in growth was observed, indicating sulfide was not a primary determinant of growth in stands of *S. cynosuroides* on Sapelo Island, Georgia. A sulfide concentration of 0.5 mM inhibited production in *B. frutescens*. In situ sulfide concentrations as high as 0.5 mM were found only in mixed stands of *Juncus roemerianus* and *B. frutescens*. (Author's abstract)

W90-05287

ONTOGENETIC CHANGES IN THE LONGITUDINAL DISTRIBUTION OF TWO SPECIES OF LARVAL FISH IN A TURBID WELL-MIXED ESTUARY.

Laval Univ., Quebec. Dept. de Biologie. R. Laprise, and J. J. Dodson. *Journal of Fish Biology* JFIBA9, Vol. 35, No. SA, p. 39-47, December 1989. 6 fig, 7 ref.

Descriptors: *Estuarine fisheries, *Fish, *Fish behavior, Habitats, Interspecific competition, Resource partitioning, Vertical distribution, Salinity, Tomcod, Smelt, Larvae, St Lawrence Estuary, Fish physiology.

The relationship between vertical migration, estuarine retention and species-specific patterns of longitudinal distribution of the pelagic larvae of rain-

bow smelt, *Osmerus mordax*, and tomcod, *Microgadus tomcod*, was investigated in the upper section of the St. Lawrence Middle Estuary. It was hypothesized that the species-specific use of the vertical pattern of current exhibited by the two species results in the partitioning of the estuarine habitat in the longitudinal plane while assuring retention. Important differences in the longitudinal distribution of tomcod and smelt larvae were related to the ontogeny of their vertical distribution in the water column. In June, small tomcod and smelt larvae are generally associated with waters of salinities less than 5 ppt. As the larvae grow, their vertical distribution patterns change, leading to a horizontal separation of the two species. Tomcod juveniles migrate downstream into colder, more saline waters, whereas larger smelt larvae migrate upstream into warmer, tidal fresh waters. Ontogenetic changes in vertical distribution serve to concentrate larvae in specific conditions that may optimize physiological conditions and also permit population persistence. (Author's abstract)

W90-05297

VELOCITY DISTRIBUTION IN ARRESTED SALINE WEDGES.

Thessaloniki Univ., Salonika (Greece). Dept. of Civil Engineering. V. Dermis.

Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPE5, Vol. 116, No. 1, p. 21-42, January/February 1990. 16 fig, 3 tab, 17 ref, 2 append.

Descriptors: *Fluid mechanics, *Estuaries, *Saline-freshwater interfaces, Salinity, Reynolds stresses, Velocity, Saline wedges, Shear stress.

The velocity distribution laws of arrested saline wedges have been experimentally studied in a tilting flume 20.24 m long, 45.72 cm wide, and 45.72 cm deep. These laws were investigated together with the interfacial and bed shear stresses through the utilization of a specially designed electronic conductivity meter for the measurement of the salinity, and hot film anemometer for the measurement of the detailed velocity distribution and the Reynolds stresses. In the immediate neighborhood of the velocity interface, and in a zone of some millimeters width, the velocity distribution is linear. This linear law appears to be independent of salinity. Outside the zone the velocity distribution is logarithmic. In particular, the logarithmic laws of the interface and of the outer region are defined for the two layers. These laws are analogous to the wall law and the law of the outer region for homogeneous fluids flow over solid boundaries. (Author's abstract)

W90-05298

TWO MANIPULATED INNER BAYS IN THE HELSINKI SEA AREA, NORTHERN GULF OF FINLAND.

Helsinki City Water and Wastewater Authority (Finland). Water Conservation Lab. For primary bibliographic entry see Field 5G. W90-05346

SEASONAL DYNAMICS OF THE CHESAPEAKE BAY ECOSYSTEM.

Maryland Univ., Solomons. Chesapeake Biological Lab. D. Baird, and R. E. Ulanowicz. *Ecological Monographs* ECOMOQ, Vol. 59, No. 4, p. 329-364, December 1989. 13 fig, 10 tab, 249 ref, append. Maryland Department of Natural Resources, grant C-11-86-023 and Contract N00024-86-C-5188.

Descriptors: *Bays, *Food chains, *Cycling nutrients, *Chesapeake Bay, Predation, Seasonal distribution, Ecosystems, Detritus, Primary productivity, Trophic level.

The full suite of carbon exchanges among the 36 most important components of the Chesapeake Bay mesohaline ecosystem is estimated to examine the seasonal trends in energy flow and the trophic dynamics of the ecosystem. Although the overall

Field 2—WATER CYCLE

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typology of the ecosystem does not appear to change substantially from season to season, there is a dominant seasonal cycle in the activities of all subcommunities, which is greatest in the summer and least in the cold season. The complicated trophic network assessed by matrix operations can be mapped into an eight-level trophic chain. Such an analysis reveals that detritivory is about 10 times greater than herbivorous grazing in the Chesapeake system and that 70% of detritus results from internal recycle. Annual efficiencies of trophic levels decrease as one ascends the chain. Major seasonal shifts in trophic efficiencies at higher levels appear to be modulated by how effectively microscopic zooplankton (mostly ciliates) are cropped by their predators. Average trophic efficiency is 9.6%. Despite the existence of eight trophic levels, the average level at which each species feeds always remains below 5. One 'pest' species (the coelenterate *Chrysaora quinquecirrha*) feeds rather high on the trophic pyramid and, as a result, may exert an unappreciated level of control on the planktonic food chain. The existence of very few cycles in the trophic network combined with relatively large and seemingly constant total system activity may indicate a stressed ecosystem. The collection of cycles present in the system is disjoint; there is no overlap between the cycles among the planktonic community and the circulations among the deposit feeders and nekton. The filter-feeding benthos and fish do not participate in any cycling, but serve rather as bridges to shift carbon and energy from the planktonic community into the benthic-nektonic subsystems. Most members of the microbial loop do not participate in carbon recycling, functioning instead as a dissipative shunt of energy out of the system. (Author's abstract)

W90-05356

ROLE OF VARIOUS MICROORGANISMS ON TC BEHAVIOR IN SEDIMENTS.

Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Lab. de Physiologie Vegetale. For primary bibliographic entry see Field 5B.

W90-05368

FACTORS AFFECTING THE DISTRIBUTION AND DIVERSITY OF POLYCHAETES IN AMVRAKIKOS BAY, GREECE.

Athens Univ. (Greece). Zoological Lab. and Museum. A. Nicolaidou, and K. N. Papadopoulos. PSZNI: Marine Ecology MAECDR, Vol. 10, No. 3, p 193-219, 1989. 3 fig, 3 tab, 21 ref.

Descriptors: *Annelids, *Greece, *Bays, *Polychaetes, *Species diversity, Bottom sediments, Amvrakikos Bay, Species distribution, Water depth, Sedimentary structures, Salinity, Replenishment, Recharge.

The polychaete fauna was studied in 18 soft-bottom stations in Amvrakikos Bay of the Ionian Sea. Of the 146 species found, a large number of them were found only once, which caused low similarity between stations. Mixing and renewal of water influenced the distribution of species and feeding types of polychaetes, while their diversity correlated with sedimentary structure. Water depth accounted for the greatest variability in the data, whereas salinity had no discernible effect on the polychaete fauna. (Author's abstract)

W90-05376

SHORT-TERM THERMAL EFFECTS OF A POWER-GENERATING PLANT ON ZOOPLANKTON IN THE SWARTKOP ESTUARY, SOUTH AFRICA.

Port Elizabeth Univ. (South Africa). Dept. of Zoology. For primary bibliographic entry see Field 5C.

W90-05377

EFFECTS OF INDUSTRIAL POLLUTION ON THE DEVELOPMENT AND SUCCESSION OF MARINE FOULING COMMUNITIES: I. ANALYSIS OF SPECIES RICHNESS AND FREQUENCY DATA.

Wollongong Univ. (Australia). Dept. of Biology. For primary bibliographic entry see Field 5C.

W90-05378

EFFECTS OF INDUSTRIAL POLLUTION ON THE DEVELOPMENT AND SUCCESSION OF MARINE FOULING COMMUNITIES: II. MULTIVARIATE ANALYSIS OF SUCCESSION.

Wollongong Univ. (Australia). Dept. of Biology. For primary bibliographic entry see Field 5C.

W90-05379

ECOLOGY OF TROPICAL SOFT-BOTTOM BENTHOS: A REVIEW WITH EMPHASIS ON EMERGING CONCEPTS.

Australian Inst. of Marine Sciences, Townsville. D.M. Alongi. Revista de Biologia Tropical RBTCAP, Vol. 37, No. 1, p 85-100, June 1989. 4 tab, 116 ref. Marine Sciences and Technologies grant no. 86107080, Australian Institute of Marine Science.

Descriptors: *Benthos, *Tropical regions, *Ecosystems, Species diversity, Benthic fauna, Predation, Bottom sediments, Species composition, Seasonal variation, Community structures.

A review of the tropical soft-bottom literature reveals that several general concepts in benthic ecology, formulated from temperate work, are either in need of modification or are not readily applicable to tropical benthic ecosystems. Several concepts emerge from the present tropical literature suggesting that in comparison with temperate communities species diversity and faunal densities are not necessarily greater in the tropics; environmental stress (excluding anthropogenic input) is generally more severe; infaunal communities are composed of proportionately more small opportunistic species; predation by demersal fishes and crustaceans is more intense; microbes may be a carbon sink in some shallow-water habitats, notably mangroves; production is generally high, but breeding and reproduction are frequently not continuous; and the distribution and abundances of tropical benthos, like most other communities, reflect temporal and spatial mosaics of major regulatory factors (competition, predation, food supply, environmental disturbances). Several tropical marine ecosystems such as mangroves and coral reefs are unique, and other environments such as continental shelves possess several common features which distinguish them to some degrees from their temperate counterparts. To confirm, reject or modify these emerging concepts, several aspects of tropical benthic ecosystems require further study, including effects of wet season activity, physiological tolerances, nutrient recycling, secondary production, benthic-pelagic coupling and pollution. Such information and emerging conceptualizations are necessary to permit proper and informed conservation management of these unique ecosystems. (Author's abstract)

W90-05384

RATES AND PATTERNS OF ESTUARINE SEDIMENT ACCUMULATION.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. G. S. Brush. Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1235-1246, November 1989. 6 fig, 4 tab, 32 ref. NSF Grants EAR81-15727 and EAR 85-17613.

Descriptors: *Chesapeake Bay, *Marine sediments, *Sedimentation rates, *Erosion, *Estuaries, Spatial distribution, Sedimentation, Sediment transport, Geomorphology, Land use, Nutrients, Temporal distribution, Pollen, Clear-cutting.

Estuarine sedimentation rates were estimated for vertical increments of sediment cores by adjusting average rates between dated horizons with the ratio of pollen concentration to concentration of sediment. The method assumes independent influxes of pollen and sediment into the estuary, similar patterns of transport and deposition for both pollen and fine sediment, a uniform influx of pollen over the time interval between dated horizons, and preservation of the majority of pollen

entering the estuary. Comparisons of detailed, pollen-derived sedimentation rates with historical records of climatic and anthropogenic events in upper Chesapeake Bay show that highest rates of sediment accumulation occur in upper and middle stretches of tidal tributaries and coincide with major storms and periods of intensive land clearance when > 20% of total land area in a given watershed is deforested and under cultivation. (Author's abstract)

W90-05393

EFFECTS OF PATCH SIZE AND SUBSTRATE ISOLATION ON COLONIZATION MODES AND RATES IN AN INTERTIDAL SEDIMENT.

Hawaii Inst. of Geophysics, Honolulu. C. R. Smith, and S. J. Brumsickle. Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1263-1277, November 1989. 9 fig, 4 tab, 50 ref. NSF Grants OCE 84-07478 and OCE 86-14367.

Descriptors: *Experimental design, *Mud flats, *Marine sediments, *Benthos, *Species diversity, *Species composition, Ecology, Succession, Population dynamics, Aquatic animals.

The dynamics of soft-bottom disturbance mosaics may be strongly influenced by life stages of colonists, disturbance size, and patch isolation. The effects of postlarval immigration, patch size, and vertical isolation on colonization was assessed following small-scale disturbance in a mudflat in Barnstable Harbor, Massachusetts. Defaunated sediment plugs of two sizes (50 and 1,750 sq cm in plan area) and two levels of isolation (flush with the seafloor and elevated 5 cm) were implanted in the flat and sampled after 4-41 days. Postlarval immigration proved a major colonization mode for both treatment sizes. Colonization rates and successional patterns varied markedly between patch sizes. Faunal abundance and species number increased more rapidly, and species proportions differed, in smaller treatments primarily because the contribution of postlarval immigration varied inversely with patch size. Colonization in elevated plugs bore little resemblance to that in flush treatments, with macrofauna accumulating in raised plugs at markedly lower rates. It was concluded that postlarval immigration may be a major mode of colonization at the study site and perhaps in soft bottoms in general following small-scale disturbance, that patch size must be considered in models of benthic colonization and succession, and that colonization trays may be used more fruitfully as explicit experimental treatments rather than the intact seafloor. (Author's abstract)

W90-05394

CARBON ISOTOPIC COMPOSITIONS OF ESTUARINE BACTERIA.

Gordon Coll., Wenham, MA. Dept. of Biology. For primary bibliographic entry see Field 7B.

W90-05398

RADIONUCLIDES AND LARGE PARTICLES IN ESTUARINE SEDIMENTS.

Phoenix Research Lab., Tavistock (England). For primary bibliographic entry see Field 5B.

W90-05405

BIOLOGICAL AND CHEMICAL COMPOSITION OF BOSTON HARBOR, USA.

Army Engineer Div. New England, Waltham, MA. For primary bibliographic entry see Field 5B.

W90-05408

SULFUR-CONTAINING AMINO ACIDS AS PRECURSORS OF THIOLS IN ANOXIC COASTAL SEDIMENTS.

Rosenstiel School of Marine and Atmospheric Science, Miami, FL. R. P. Kiene, K. D. Malloy, and B. F. Taylor. Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 156-161, January 1990. 10 fig, 1 tab, 37 ref. NSF grant OCE-

8516020.

Descriptors: *Marine sediments, *Coastal waters, *Organic matter, *Amino acids, *Thiols, *Bio-transformation, *Microbial degradation, Sulfur, Chemical binding, Inhibition, Metabolites.

Sulfur-containing amino acids were examined as precursors for thiols in anoxic coastal sediments. Substrates (10-100 microM) were anaerobically incubated with sediment slurries. Thiols were assayed as isoindoles derivatives by high-performance liquid chromatography. Microbial transformations of thiols, in contrast to their chemical binding by sediment particles, were identified by inhibition with a mixture of chloramphenicol and tetracycline. Methionine and homocysteine were transformed to methanethiol and 3-mercaptopropionate (3-MPA); methionine stimulated mainly methanethiol production, whereas homocysteine generated more 3-MPA than methanethiol. 2-Keto-4-methylbutyrate yielded results similar to those with methionine, indicating that demethiolation yields methanethiol at the keto-acyl level. Glutathione gave rise to cysteine, which was further transformed to 3-mercaptopropionate and thence to mercaptoacetate and mercaptoethanol. Mercaptoethanol was oxidized to mercaptoacetate, which was biologically consumed. In conclusion, sulfur-containing amino acids contribute to the range of thiols that occur in anoxic coastal sediments. New metabolic and environmental transformations were identified: the production of 3-MPA as a metabolite of methionine and the transformation of mercaptopropionate to mercaptoethanol and mercaptoacetate. (Author's abstract)

W90-05485

EFFICIENCIES OF RECOVERY OF BDELLOVIBRIOS FROM BRACKISH-WATER ENVIRONMENTS BY USING VARIOUS BACTERIAL SPECIES AS PREY.

Maryland Univ., Baltimore. Dept. of Microbiology.

A. J. Schoeffield, and H. N. Williams.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 230-236, January 1990. 3 fig, 2 tab, 23 ref. NSF grant OCE-8746188.

Descriptors: *Marine bacteria, *Bdellovibrio, *Brackish water, *Saline water, Culturing techniques, Vibrio, Predatory bacteria.

A total of 44 bacterial species subdivided into 10 trial experiments were used as prey for the recovery of bdellovibrios from samples of water from a brackish tidal pond and an aquarium saltwater tank. In an initial investigation, the recovery of each of the test bacterial species was compared with that of a designated standard prey, *Vibrio parahaemolyticus* P-5. In each case strain P-5 yielded an equal or significantly greater number of plaques of bdellovibrios than the test prey but with a single exception, strain CS5. In repeat experiments, CS5 yielded fewer plaques than P-5. To determine whether the use of multiple bacterial species compared with a single species as prey would increase the number of PFU of bdellovibrios recovered, material from plaques appearing on each of the test prey in the respective trials was sequentially subcultured into two respective agar plates, the first containing as prey *V. parahaemolyticus* P-5 and the second containing the initial test organism. In nearly every case, subculture of plaques from lawns of the test prey and P-5 did not result in the recovery of any more bdellovibrio PFU than the use of P-5 alone. P-5 was observed to be the most efficient prey for the recovery of bdellovibrios from moderate salt water. (Author's abstract)

W90-05486

EFFECTS OF ACID STRESS ON AEROBIC DECOMPOSITION OF ALGAL AND AQUATIC MACROPHYTE DETRITUS: DIRECT COMPARISON IN A RADIOCARBON ASSAY.

Georgia Univ., Athens. Inst. of Ecology.

For primary bibliographic entry see Field 2H.

W90-05487

LARVAL FISH AND SHELLFISH TRANSPORT THROUGH INLETS.

For primary bibliographic entry see Field 8L.

W90-05532

SHELF-ESTUARINE WATER EXCHANGES BETWEEN THE GULF OF MEXICO AND MOBILE BAY, ALABAMA.

Louisiana State Univ., Baton Rouge. Coastal Studies Inst.

W. J. Wiseman, W. W. Schroeder, and S. P. Dinnel.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 1-8. 7 fig, 2 tab, 18 ref.

Descriptors: *Water circulation, *Estuaries, *Mobile Bay, *Bays, *Flow, Fluctuations, Flow measurement, Wind-driven currents, Continental shelf, Water exchange.

Main Pass connects Mobile Bay, a broad, shallow estuary in Alabama with the Gulf of Mexico. The Pass is 5.4 km wide. Its western two-thirds is only 4 m deep, but depths as great as 15 m occur in the eastern section. Main Pass carries approximately 85% of the mass flux between Mobile Bay and the adjacent continental shelf waters. The remaining 15% flows through Pass-aux-Herons, which connects Mobile Bay to east Mississippi Sound. One month of current meter data from Main Pass demonstrated shelf-estuarine exchange driven by north-south wind stress at periodicities longer than the tide. Riverine discharge fluctuations may modulate the gravitational circulation over time scales shorter than seasons. Tidal diffusion, long-period advection, and the mean circulation are of equal importance to dispersion of water through Main Pass. (See also W90-05532) (Mertz-PTT)

W90-05533

TRANSPORT MODEL FOR WATER EXCHANGE BETWEEN COASTAL INLET AND THE OPEN OCEAN.

State Univ. of New York at Stony Brook. Marine Sciences Research Center.

D. P. Wang.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 9-15. 4 fig, 9 ref.

Descriptors: *Larvae, *Inlets, *Model studies, *Water circulation, *Jetties, Wind-driven currents, Gravity, Tidal currents, Environmental impact statement, Three-dimensional model, Force balance, Mass conservation, Salt conservation, Density stratification.

A numerical model capable of predicting interactions between coastal inlets and the open ocean is a useful tool for assessment of environmental impacts. Most previous estuarine models have been based on the assumption of a two-dimensional flow field, which is quite restrictive for studies of water exchange between inlets and open ocean. An example of using a generalized, three-dimensional, density-stratified model to simulate the inlet-ocean interaction is presented. A three-dimensional model solves a set of partial differential equations that describe the force balance, the mass conservation, and the salt conservation. Mixing and dissipation are subgrid processes, that is, they occur in spatial scales much smaller than those resolved by a circulation model, which must be parameterized. Results indicate that dispersal of the outflow plume is the combined effect of tidal, gravity, and wind-driven currents. Jetty construction near an inlet entrance will displace the discharge plume off the coast. If the seaward extension of the jetty is much smaller than the dimensions of the plume, the jetty will not have important effects on the plume. If the jetty and the plume have a similar seaward dimension, the jetty will distort and enlarge the plume. Most likely, the discharge plume will become more diluted when there is a jetty. Using the model, it may be possible to assess effects of jetty construction on the transport of larvae. (See also W90-05532) (Mertz-PTT)

W90-05534

OBSERVATIONS ON INLET FLOW PATTERNS DERIVED FROM NUMERICAL AND PHYSICAL MODELING STUDIES.

Coastal Engineering Research Center, Vicksburg, MS.

W. C. Seaberg.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 16-25. 10 fig, 13 ref.

Descriptors: *Inlets, *Jetties, *Larvae, *Estuaries, Larval transport, Wind-driven currents, Flow, Wind waves, Flow pattern, Hydrodynamics, Model studies.

Due to its responsibility to provide navigable entrance channels through coastal inlets, the U.S. Army Corps of Engineers has conducted numerous site-specific model studies of tidal inlets and has performed generalized research on tidal inlets. Tidal inlet systems can be viewed hydrodynamically as varying from relatively simple flow orifices to rather complex flow systems as the number of influencing parameters increases. Wind waves, freshwater inflow, and wind stress on the water surface can cause significant effects. The scale of inlets extends from the very small to the very large and the extent of their influence along the coast varies proportionately to their size. As jetties are added to an inlet for producing channel stability and navigation safety, local changes to the flow patterns occur. At this stage of research, it would be difficult to determine the net effect that hydrodynamics would have on larval recruitment into the estuary. (See also W90-05532) (Mertz-PTT)

W90-05535

SAMPLING OPTIMIZATION FOR STUDIES OF TIDAL TRANSPORT IN ESTUARIES.

South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.

B. Kjerfve, and T. G. Wolaver.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 26-33. 4 fig, 1 tab, 15 ref. National Science Foundation Grant DEB-8119752.

Descriptors: *Flow measurement, *Sampling, *Estuaries, *South Carolina, *Tidal effects, Water circulation, Water discharge, Nitrogen, Organic carbon, Chemical properties.

Measurements of material and water transport in estuarine cross sections are costly and require a substantial effort. It is desirable to optimize the sampling design by reducing the effort and cost without losing important information in the process. An intense calibration program was developed to formulate a long-term sampling design that is optimal in terms of cost, feasibility, and errors. To illustrate how to optimize a sampling design in a tidal transport study, fluxes of water, nitrogen (nitrate plus nitrite), and particulate organic carbon were recalculated and analyzed through a cross section of a South Carolina marsh creek during two tidal cycles. Discharge explained 95% of the variation in nitrate plus nitrite flux and 92% of the variation in particulate organic carbon flux. The remaining fluxes were presumed to result from biogeochemical marsh-estuary processes. Because nontidal transport is usually of great interest yet is often masked by tidal dynamics, it is essential to make careful flow measurements to assess biogeochemical processes from direct flux measurements. (See also W90-05532) (Author's abstract)

W90-05536

PHYSICAL OCEANOGRAPHIC PROCESSES AFFECTING LARVAL TRANSPORT AROUND AND THROUGH NORTH CAROLINA INLETS.

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.

L. J. Pietrafesa, and G. S. Janowitz.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 34-50. 17 fig, 35 ref. Department of Commerce Grant NA81AA-D-00026 and U.S. Department of Energy Grants DOE-76-AS09-EY00902 and DE-FG09-85ER60376.

Field 2—WATER CYCLE

Group 2L—Estuaries

Descriptors: *Estuaries, *Inlets, *North Carolina, *Croakers, *Flounders, *Spot croakers, *Menhaden, *Fish migration, Tidal effects, Flow, Larvae, Larval transport.

Atlantic croaker (*Micropogonias undulatus*), flounders (*Paralichthys* species), spot (*Leiostomus xanthurus*), and Atlantic menhaden (*Brevortia tyrannus*) all spawn in the continental shelf waters of North Carolina during late fall to early winter. The juveniles use the bays and tributaries adjoining estuaries such as Pamlico Sound and the Cape Fear River as nurseries during their first winter and spring. In previous studies of recruitment into the estuaries through barrier island inlets or estuarine mouths, it was assumed that both larvae and juveniles entered the estuaries at the bottom of the water column and moved upstream thereafter. The mechanisms were presumed to be tidal. Larvae can enter Pamlico Sound through Oregon, Hatteras, and Ocracoke inlets not only during flood stages of the tide but also in the presence of favorable ocean-to-estuary sea-level pressure gradients. The Cape Fear River has strong semidiurnal flood and ebb tidal flows and also responds vigorously to one-sided divergences and convergences of the adjacent coastal ocean. Facing seaward, flow at the river mouth is in at the left and out on the right. In addition to flooding tides, nonlocal forcing at the estuary mouths can effect transport of larval fish through the estuary mouths, throughout the entire water column. (See also W90-05532) (Author's abstract) W90-05537

ROLES OF BEHAVIORAL AND PHYSICAL FACTORS IN LARVAL AND JUVENILE FISH RECRUITMENT TO ESTUARINE NURSERY AREAS.

National Marine Fisheries Service, Honolulu, HI. Honolulu Lab.
G. W. Boehlert, and B. C. Mundy.
IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 51-67. 4 fig. 1 tab, 121 ref. National Science Foundation Grant OCE-80-25214.

Descriptors: *Fish behavior, *Estuaries, *Fish migration, *Tidal effects, Fish, Larvae, Spawning, Larval transport, Physical properties.

Recruitment to and maintenance in estuaries are important parts of the early life history of many fish species. Field studies have documented patterns of estuarine recruitment for several species; although some studies have postulated passive mechanisms for recruitment, the majority suggest specific behavior patterns that clearly correlate with physical factors or other stimuli. Recruitment to the estuary of species spawned offshore was considered as a two-stage process dependent first upon factors in the offshore planktonic environment and second upon estuarine factors related to tidal flux. Rather than a simple stimulus-response mechanism related to a single physical factor, it is suggested that the suite of factors associated with tidal flux at particular locations may act as the zeitgeber for an endogenous rhythm with a tidal periodicity. In this manner, an animal may use tidal-stream transport both for movement into the estuary and for maintenance within the estuary. Further work in the laboratory is necessary to elucidate these behaviors in fishes, particularly those related to endogenous rhythms and the stimuli that serve as zeitgebers. (See also W90-05532) (Author's abstract) W90-05538

PHYSICAL PROCESSES AND THE MECHANISMS OF COASTAL MIGRATIONS OF IMMATURE MARINE FISHES.

North Carolina State Univ. at Raleigh. Dept. of Zoology.
J. M. Miller.
IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 68-76. 57 ref. NOAA Grant NA85AA-D-00012.

Descriptors: *Fish migration, *Flounders, *Eels, *Capelin, *Coastal waters, *Herring, Physical

properties, Water temperature, Salinity, Turbidity, Odors, Tidal effects, Hydrodynamics, Fish populations.

Migrations of immature marine fishes begin as passive drift, then develop into active swimming as the fish grow. The migration mechanisms of larval plaice (*Pleuronectes platessa*), anguillid eels (*Anguilla* species), capelin (*Mallotus villosus*), and Atlantic herring (*Clupea harengus harengus*) illustrate various degrees of active responses to hydrographic regimes. Passively and actively migrating larvae must have opposite orientations to coastal gradients of odors, temperature, salinity, or turbidity. To be transported shoreward, passively migrating larvae should be attracted to water with the opposite characteristics of their destination. Although an active mechanism of selective tidal stream transport has been suggested in several cases, a mechanism based on a passive buoyancy response is suggested as an alternative. To detect an active component of migration, a three-dimensional hydrodynamic description of the migratory environment is necessary. In most cases, this means that synoptic physical studies must accompany biological investigations of immature fish migration, because adequate three-dimensional hydrodynamic models do not exist for most estuarine systems. More precise descriptions of the vertical distributions of fish are also needed. With better measurements, the relationships between fish movements and physical features of environments, if quantified, could be used to predict the distribution of fish during or after migration. (See also W90-05532) (Mertz-PTT) W90-05539

OCEAN-ESTUARY COUPLING OF ICHTHYOPLANKTON AND NEKTON IN THE NORTHERN GULF OF MEXICO.

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
R. F. Shaw, B. D. Rogers, J. H. Cowan, and W. H. Herke.
IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 77-89. 6 fig, 58 ref. Louisiana Department of Wildlife and Fisheries and the U.S. Department of Energy cooperative agreement DE-FC96-81P010313, U.S. Fish and Wildlife Service cooperative agreement 14-16-0009-79-1003, and the U.S. Soil Conservation Service contract 53-7217-1-23.

Descriptors: *Gulf of Mexico, *Coastal waters, *Menhaden, *Sea trout, *Fish migration, *Estuaries, Spawning, Tidal effects, Hydrodynamics, Oceans, Larvae, Fish larvae, Louisiana, Stratification, Vertical stratification, Water circulation.

Both gulf menhaden (*Brevortia patronus*) and sand seatrout (*Cynoscion arenarius*) spawn offshore in the Gulf of Mexico during winter and spring. After a cross-shelf transit, their larvae later enter estuarine nursery areas. New and existing early life history data on the occurrence of these species in the continental shelf ichthyoplankton and as late-stage larvae and juveniles in Louisiana estuaries has been used to document this recruitment process. The sequential appearances and length-frequency data from larvae in the offshore plankton and larvae and juveniles in the estuarine marsh, as well as growth rates inferred from daily otolith increments, imply shelf-to-estuary transit times of 40-73 days for gulf menhaden and an upper range of 30-94 days for sand seatrout. During these times, water mass movements near the coast displace larvae to the west-northwest for distances that may measure several hundreds of kilometers, i.e., larvae do not necessarily recruit to estuaries nearest their offshore spawning areas. Additional information on hydrodynamics, e.g., coastal ocean-estuarine exchange mechanisms, and on the behavior of fish larvae with respect to vertical stratification and water movements will be needed to define better the controls on estuarine recruitment of these and other species in the northern Gulf of Mexico. (See also W90-05532) (Author's abstract) W90-05540

EXPORT AND REINVASION OF LARVAE AS REGULATORS OF ESTUARINE DECAPOD POPULATIONS.

Old Dominion Univ., Norfolk, VA. Dept. of Oceanography.
J. R. McConaughy.
IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 90-103. 7 fig. 4 tab, 78 ref. NOAA Grants NA79AA-D-00055, NA81AA-D-0025, NA85AA-D-SG016, and NA86AA-D-SG042.

Descriptors: *Fish migration, *Estuaries, *Crustaceans, *Larvae, *Coastal waters, Continental shelf, Wind currents, Wind, Flow, Fluctuations.

Larvae of decapod crustacean species residing or spawning in lower estuaries can be retained within the estuary, advected to the adjacent continental shelf (20-30 km offshore), or expelled and widely distributed across the shelf. For species whose larvae are advected from the estuary, year-to-year variations in transport processes can alter the year-class strength. Decapod larvae that are widely distributed across the continental shelf tend to be concentrated in the upper 3 m of the water column. For these species, larval distributions and transport are highly correlated with wind events. Larvae of other species that move only short distances from the estuary are concentrated at depth. Diurnal vertical migrations may be the basic mechanism by which these larvae are retained near the estuary. Selection pressures for retaining a long planktotrophic larval stage that is advected from the estuary include gene flow between estuaries, physiological requirements of the larvae (i.e., temperature and salinity tolerances), and reduced predation. (See also W90-05532) (Author's abstract) W90-05541

TRANSPORT OF INVERTEBRATE LARVAE BETWEEN ESTUARIES AND THE CONTINENTAL SHELF.

Delaware Univ., Newark. Coll. of Marine Studies.
C. E. Epifanio.
IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 104-114. 6 fig, 67 ref. NOAA Grant NA85AA-D-SG033, project R//M-4.

Descriptors: *Estuaries, *Invertebrates, *Larvae, Plankton, Reproduction, Gene flow, Predation, Flow pattern, Fish populations, Coastal waters.

Marine and estuarine invertebrates display a spectrum of reproductive strategies. These include: (1) direct development, whereby the larval stage is bypassed in the egg; (2) brooding, whereby larvae are held within the body of the adult female; (3) nonfeeding lecithotrophic development, whereby larvae are free in the plankton but rely on self-contained yolk for nourishment; and (4) planktotrophic development, whereby larvae are free in the plankton and prey on other planktonic species for nourishment. Planktotrophic development is by far the most common reproductive strategy among tropical and temperate species. Advantages of this mode of development are several and include high potential to take advantage of newly available habitat, extensive gene flow among dispersed populations, and exploitation of different habitats during larval and adult life. Concomitant disadvantages include increased vulnerability to predation or starvation and the possibility of advection away from habitats suitable for adult or juvenile existence. The problem of advection is most acute for species living in estuaries where subtidal flow (vertically averaged) is seaward. The mechanisms for retention of these larvae in estuaries have been of great interest to marine scientists for nearly a century. Human-induced changes in estuarine flow patterns should affect species with retained larvae more than those with exported larvae. Activities that alter flow patterns in the mouths of estuaries or affect the inner continental shelf would have the greater effects on species with exported larvae or those whose larvae develop on the continental shelf before postlarval invasion of estuarine nursery areas. (See also W90-05532) (Mertz-PTT) W90-05542

MODELING OF PHYSICAL AND BEHAVIORAL MECHANISMS INFLUENCING RECRUITMENT OF SPOT AND ATLANTIC CROAKER TO THE CAPE FEAR ESTUARY.

Lawler, Matusky and Skelly Engineers, Pearl River, NY.
J. P. Lawler, M. P. Weinstein, H. Y. Chen, and T. L. Engler.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 115-131. 14 fig, 6 tab, 12 ref.

Descriptors: *Mathematical models, *Spot croakers, *Croakers, *North Carolina, *Fish populations, Fish migration, Water circulation, Growth, Model studies, Flow, Hydrodynamics, Fish behavior, Cape Fear Estuary.

A series of mathematical models was developed to simulate spot (*Leiostomus xanthurus*) and Atlantic croaker (*Micropogonias undulatus*) transport to, and accumulation in, primary nurseries of the Cape Fear estuary, North Carolina. The ultimate product of this effort was the Cape Fear fish population model used to describe the physical and behavioral mechanisms influencing the recruitment process. Because recruitment seemed to be a two-stage phenomenon, influenced initially by advective (hydrodynamic) processes and later by behavioral traits of the organisms themselves, a salt-budget model was developed first. This model evaluated the hydrodynamics by estimating the net nontidal flows in the estuary under various freshwater flow conditions. The second model, the fish population model, incorporated these net nontidal flows with the life cycle parameters and behavioral mechanisms to simulate the distribution and growth of spot and Atlantic croakers inside the estuary. Larvae and early juveniles of both species were perceived to be transported into the estuary by the ocean exchange rate at the estuary mouth. Once inside the estuary, juvenile spot concentrated near the bottom during the day and were transported to the upriver nursery areas by the lower-layer flow. At night, spot were evenly distributed in the water column, and thus could reach the tributary creek and marsh nursery areas via the flood tide into the creeks. Most Atlantic croakers, in contrast, concentrated near the bottom at all times and therefore were found primarily in the upriver nursery areas. Thus, physical mechanisms—represented by the diurnal vertical migration patterns—played major roles in the recruitment and distribution of these two species in the Cape Fear estuary. Construction activities at and around inlets can interfere with recruitment rates, recirculation, behavioral cues, and other components of estuarine recruitment; the models described here have the potential to predict the outcome of inlet modification. (See also W90-05532) (Mertz-PTT)
W90-05543

DISTRIBUTION OF FISH EGGS AND LARVAE AND PATTERNS OF WATER CIRCULATION IN NARRAGANSETT BAY, 1972-1973.

Marine Research, Inc., Falmouth, MA.
D. W. Bourne, and J. J. Govoni.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 132-148. 10 fig, 6 tab, 44 ref.

Descriptors: *Fish populations, *Plankton, *Rhode Island, *Estuaries, *Flow pattern, *Water circulation, Narragansett Bay, Ichthyoplankton, Fluctuations, Spawning, Water pollution effects, Gravity, Fish, Bays.

About 42 species of ichthyoplankton, belonging to 28 families, were identified in some 6900 plankton samples taken throughout Narragansett Bay, Rhode Island, between June 1972 and August 1973. One hundred sixty stations were established in 10 sampling sectors. Usually there were statistically significant population differences among these sectors, though confidence limits varied considerably among sectors and taxa. Species abundances varied from north to south in the bay, and some of the heaviest spawning occurred in the northern, most polluted part. Six or seven species accounted for 95% of all individuals. Between-year variation in numbers of a single species sometimes exceeded 100%. Limited sampling at discrete

depths indicated that about 75% of the ichthyoplankton were in the upper half of the water column. Gravitationally forced water movement is apparently an important determinant of ichthyoplankton distribution and retention in Narragansett Bay, a partially mixed estuary. (See also W90-05532) (Author's abstract)
W90-05544

NULL HYPOTHESES, MODELS, AND STATISTICAL DESIGNS IN THE STUDY OF LARVAL TRANSPORT.

National Marine Fisheries Service, Beaufort, NC.
D. R. Colby.

IN: Larval Fish and Shellfish Transport through Inlets. American Fisheries Society, Bethesda, MD. 1988. p 149-162. 5 fig, 2 tab, 79 ref.

Descriptors: *Statistical methods, *Larvae, *Model studies, *Larval transport, Fish, Null hypothesis, Research priorities, Estuaries, Computer models, Fluctuations, Stochastic models.

In larval transport investigations, the broad range of relevant spatial and temporal scales, the imprecision of measurements of organism abundance, and the potentially complex motions of water masses are particular concerns in developing research designs. These concerns underscore a need both for collaboration between biologists and physicists, and for rapid adoption of emerging technologies for measuring relevant processes at appropriate scales in the field. Many branches of statistics have application to larval transport investigations. Requirements for accurate description imply a need for greater emphasis on statistical estimation procedures and attention to sources of bias, and accordingly less emphasis on statistical hypothesis testing, especially with observational data. Strong null hypothesis should be advanced that are consistent with common experience and reflect current knowledge. They then provide an invaluable framework against which to compare empirical data. In larval transport research, advection-diffusion models, physical models, explicit conceptual models, and stochastic models all can serve as null hypotheses. Random-walk, Markov-chain models of the movements and expected vertical distribution of larvae in the water column have merit for studies of vertical migration as a transport mechanism. They also can be used to model the accumulation of larvae along shorelines and other boundaries and may help explain layering of oceanic plankton. Spatial and temporal scales, target and sampling populations, independent replication, and sampling gear bias are among the concepts that require attention in the design of studies of the flux of larvae through an inlet, or of a particular transport mechanism. Because, in larval transport studies, a variable of interest may change in response to many external factors, careful examination of patterns of covariation may provide more insight than will a focus on average values. New statistical approaches, such as the bootstrap, offer promising alternatives to traditional statistical methodologies, and they underscore the increasing application of computers to all phases of larval transport research, from research design and data acquisition to data analysis and stochastic modeling. (See also W90-05532) (Author's abstract)
W90-05545

BEAUFORT SEA MESOSCALE CIRCULATION STUDY—FINAL REPORT.

National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.

K. Aagaard, C. H. Pease, A. T. Roach, and S. A. Salo.

NOAA Technical Memorandum ERL PMEL-90, November 1989. 114p, 60 fig, 24 tab, 80 ref.

Descriptors: *Water currents, *Beaufort Sea, *Upwelling, *Ocean circulation, Water circulation, Continental shelf, Wind-driven currents, Salinity, Meteorology.

The Beaufort Sea Mesoscale Project was undertaken to provide a quantitative understanding of the circulation over the Beaufort Sea shelf and of its

atmospheric and oceanic forcing. Major emphasis has been placed on providing extensive synoptic oceanographic and meteorological coverage of the Alaskan Beaufort Sea during 1986-88. In addition, supplementary measurements have been made in the southern upstream waters of Bering Strait and the Chukchi Sea. The principal conclusions are as follows: (1) Below the upper 40-50 m of the ocean, the major circulation feature of the outer shelf and slope is the Beaufort Undercurrent, a strong flow which is directed eastward in the mean, but which is subject to frequent reversals toward the west. The reversals are normally associated with upwelling onto the outer shelf; (2) Despite the seasonally varying wind field, as well as the large seasonal differences in the upper ocean temperature and salinity fields, there is no evidence for a seasonal variability in the subsurface circulation in the Beaufort Sea; (3) In contrast to the lack of a seasonal oceanographic signal at depth, the interannual variability in the flow characteristics can be considerable. For example, during the period fall 1986-spring 1987, the Beaufort Undercurrent appears to have been deeper by 30-40 m compared with both earlier and ensuing measurements; and (4) During much of the experiment, the meteorological conditions were milder than normal, consistent with less coastal ice in the summer and autumn, the passage of more storms up the west coast of Alaska and across the North Slope, and generally higher air temperatures along the North Slope. These climatological near-minimum ice years were followed in 1988 by the heaviest summer ice along the Chukchi coast since 1975. (Lantz-PTT)
W90-05555

ECOLOGY OF TAMPA BAY, FLORIDA: AN ESTUARINE PROFILE.

Mangrove Systems, Inc., Tampa, FL.
R. R. Lewis, and E. D. Estevez.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-130488. Price codes: A06 in paper copy, A01 in microfiche. Biological Report 85(7.18), September 1988. 132p, 85 fig, 27 tab, 275 p.

Descriptors: *Ecology, *Estuaries, *Tampa Bay, *Urbanization, *Ecological effects, Florida, Geo-hydrology, Water chemistry, Biological studies, Phytoplankton, Mangrove swamps, Wetlands, Fish, Sea grasses, Water quality.

Tampa Bay is Florida's largest open-water estuary and one of the most highly urbanized. This report summarizes and synthesizes many years of scientific investigation into Tampa Bay's geology, hydrology and hydrography, water chemistry, and biotic components. The estuary is a phytoplankton-based system, with mangroves being the second most important primary producer. Benthic organisms are abundant and diverse, although in parts of the bay the benthos consists of a relatively few opportunistic and pollution tolerant species. The estuary provides habitat for the juveniles and adults of a number of commercial and recreational fishery species. Significant changes occurring as a result of urbanization and industrialization includes significant declines in intertidal wetlands and seagrass meadows, changes in circulation and flushing, and degradation of water quality. Important management issues include dredge and fill operations, restoration of fisheries, increasing freshwater flow to the bay, and eutrophication. (Author's abstract)
W90-05617

GENERAL METHOD FOR GENERATING BATHYMETRIC DATA FOR HYDRODYNAMIC COMPUTER MODELS.

Geological Survey, Sacramento, CA. Water Resources Div.

For primary bibliographic entry see Field 7C.
W90-05620

Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3A—Saline Water Conversion

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

STUDIES ON PERFORMANCE OF DESALINATION PLANT WITH REVERSE OSMOSIS SYSTEM-I, (IN JAPANESE).

T. Araki, Y. Furukata, and T. Nishiyama. Bulletin of the Faculty of Fisheries Nagasaki University, No. 66 p 37-52, November 1989. 8 fig, 5 tab, 10 ref. English summary.

Descriptors: *Desalination, *Desalination plants, *Reverse osmosis, *Japan, Filters, Density, Pressure, Citric acid.

The general performance of a desalination plant with reverse osmosis modules varies with the operation and type of sea water filter. A series of experiments were conducted on board the Kakuyo-Maru to determine the amount and quality of desalinated water produced from a 7 cu m/d filter plant using a variety of chemicals to refresh the module from May 1982 to December 1988. The experiments were divided into three parts: (i) under changing pressures; (ii) different water densities; and (iii) for two different kinds of filter systems. The following results were obtained: (1) the amount of desalinated water increased with inlet pressure and the filtering capacity of the module is maintained for a longer period of time under conditions of constant inlet water pressure; (2) the performance of the module is greatly affected by the ability of the filters; and (3) the washing of the module with a chemical solution, such as citric acid, is highly effective for increasing its filtering capacity. (Author's abstract) W90-04852

APPROXIMATE ANALYTICAL SOLUTION FOR THE PERFORMANCE OF REVERSE OSMOSIS PLANTS.

King Saud Univ., Riyadh (Saudi Arabia). Dept. of Chemical Engineering. A. E. S. Al-Zahrani, M. A. Soliman, and I. S. Al-Mutaz. Desalination DSLNAH, Vol. 75, No. 1-3, p 15-24, 1989. 3 ref.

Descriptors: *Desalination, *Saline water, *Reverse osmosis, Model studies, Mathematical models, Membranes.

Recent developments in membrane technology and appropriate construction material made reverse osmosis plants attractive for large desalting projects. The demand for reverse osmosis has grown especially in sea water desalting. It can be considered the optimum process in areas where sufficient electric power is available at low cost. For these reasons, mathematical modeling of reverse osmosis plants has become an important task in the design procedure. The partial differential equations representing the material and momentum balances inside a hollow fine fiber reverse osmosis model are discretized by the method of orthogonal collocation. The approximate analytical solution is then obtained by applying the one point collocation method in the radial and axial direction. This leads to simple expressions for the recovery and product concentration. The obtained expressions are compared by the more exact results obtained by using higher order collocation method. (Author's abstract) W90-05427

NEW DUAL-FUNCTION DEVICE FOR OPTIMAL ENERGY RECOVERY AND PUMPING FOR ALL CAPACITIES OF RO SYSTEMS.

Kuwait Inst. for Scientific Research, Safat. M. A. Darwish, M. Abdel-Jawad, and L. J. Hauge. Desalination DSLNAH, Vol. 75, No. 1-3, p 25-39, 1989. 8 fig, 1 tab, 6 ref.

Descriptors: *Desalination, *Reverse osmosis, Kuwait, Energy consumption, Seawater, Economic aspects.

The cost of energy consumption represents more than 50% of the total desalting water cost by reverse osmosis (RO) for conditions prevailing in Kuwait. Real prospects of decreasing this energy consumption exist by recovering the energy of the high pressure rejected brine. This rejected brine flowrate is about 70% of the feed flowrate and at pressure slightly below the feed pressure. In a single stage seawater RO desalting system, experience in Doha RO experimental station indicated that the energy consumed by the feed pump can be decreased by 27% when a reversed centrifugal pump type turbine is used as an energy recovery device. A similar saving of 38% is expected when a Pelton wheel type turbine will be installed shortly in Doha RO station. Towards the maximum development in reducing energy consumption, a new rotor type pressure exchanger is now under development as an energy recovery and pumping device for RO seawater desalting system at Kuwait Institute for Scientific Research. Preliminary experiments proved the success of the device in recovering most of the energy from the rejected brine and decreasing the pumping energy of the feed to the membrane modules by 60%. This percentage represents the maximum saving of energy that can be sought in the RO seawater desalting technology. Through this development, the cost of desalting seawater can approach the cost of desalting brackish water, a significant advancement in desalting seawater by RO technology. The technical characteristics of the pressure exchanger and its performance as an energy recovery device for RO system under real operating conditions in the Persian Gulf area is presented along with a flow sheet that links the new device with the feed pump, rejected brine connections and booster pump. (Author's abstract) W90-05428

PREDICTABILITY OF MEMBRANE PERFORMANCE OF REVERSE OSMOSIS SYSTEMS FOR SEAWATER DESALINATION.

Kuwait Inst. for Scientific Research, Safat. B. A. Q. Darwish, G. S. Aly, H. A. Al-Rqobah, and M. Abdel-Jawad. Desalination DSLNAH, Vol. 75, No. 1-3, p 55-69, 1989. 8 fig, 6 ref.

Descriptors: *Desalination, *Reverse osmosis, *Seawater, Mathematical models, Design, Membranes, Dissolved solids, Permeate flow.

A mathematical model was tested to predict the performance of two different membrane configurations at Doha Reverse Osmosis Plant (DROP). The model is based on a generalized transport equation system involving solvent water and any number of completely ionized solutes with different valencies. A comprehensive operating data base was used for parameter estimation of some process variables involved in the mathematical model. An interactive computer program was designed to decode the model. It delivers different ionic concentration profiles and permeate flow rate for each stage of any membrane configuration system. The program can be used for both performance evaluation of existing plants and configuration design of new reverse osmosis plants. The prediction of membrane performance, expressed as product total dissolved solids and permeate flow rates, could be accomplished successfully for the spiral wound membrane configuration (RO-1) and less successfully for the hollow fiber membrane configuration (RO-2). For RO-1 the average error in total dissolved solids was 6.9% for the first stage, and 14.9% for the second stage, while the average error in permeate flow rate was 1.9% and 1.8% respectively. For RO-2, the average error in total dissolved solids was 12.8% for the first stage, and 24.5% for the second stage, while the average error in permeate flow rate was 6.7% and 9.8% respectively. The higher average errors for the second stage of both configurations are partially attributed to the very low concentrations of some ions that approach the detection limits of the analytical instruments used for element analysis. (Author's abstract) W90-05429

HYDRAULIC TURBOCHARGER(TM): A NEW TYPE OF DEVICE FOR THE REDUCTION OF

FEED PUMP ENERGY CONSUMPTION IN REVERSE OSMOSIS SYSTEMS.

Naval Civil Engineering Lab., Port Hueneme, CA. J. Lozier, E. Oklejas, and M. Silbernagel. Desalination DSLNAH, Vol. 75, No. 1-3, p 71-83, 1989. 4 fig, 2 ref.

Descriptors: *Desalination, *Reverse osmosis, Seawater, Brackish water, Hydraulic turbocharger, Performance.

A new type of reject stream energy recovery device, called the Hydraulic Turbocharger, has been developed for brackish and seawater reverse osmosis systems. The device is a feedwater lubricated, free running, high speed turbine driven pump that provides a pressure boost to the RO (reverse osmosis) feed stream resulting in a reduction in high pressure pump energy requirements. A pre-production prototype was tested at the Naval Civil Engineering Laboratory, Port Hueneme, CA in conjunction with the development of a 1200 gph Reverse Osmosis Water Purification Unit. Testing consisted of approximately 2000 operating hours in a simulated RO system operating at a nominal 60 gpm of feed flow using Pacific Ocean seawater to determine unit reliability under actual seawater operating conditions. The device operated without any failure although a performance loss did occur that was attributed to galvanic corrosion between graphite and bronze sealing surfaces. Bronze/graphite interfaces were upgraded to either silicon nitride/graphite or silicon nitride/bronze surfaces and testing resumed to determine performance characteristics of the new seal and bearing configurations. (Author's abstract) W90-05430

DESIGN METHOD OF REVERSE OSMOSIS UNITS USED IN DESALINATION.

Department of Chemical Engineering, University of Technology, Baghdad, Iraq. M. S. Hameed.

Desalination DSLNAH, Vol. 75, No. 1-3, p 85-96, 1989. 6 fig, 15 ref.

Descriptors: *Desalination, *Reverse osmosis, Design criteria, Mathematical equations, Brackish water, Seawater, Spiral wound membranes.

A comprehensive study has been carried out to develop a method for design of a reverse osmosis process for desalination. The method is based on mathematical equations used to calculate various parameters affecting design procedure. Design steps have been recommended for different membrane configurations and tested for spiral wound membranes for brackish and for seawater. The present results have been compared with other known design methods and found to be in good agreement with the approximate method. The design procedure can be used to obtain the required design variables provided that module specifications are available. The design method confirmed membrane area increase corresponding to total dissolved solids of intake water and increased rate of removal of dissolved salt, especially for product water of 50 to 200 ppm total dissolved solids. (Author's abstract) W90-05431

SIMPLIFIED ANALYSIS OF TRANSPORT IN REVERSE OSMOSIS (RO) HOLLOW FIBERS (HF) MEMBRANES.

Kuwait Inst. for Scientific Research, Safat. M. Abdel-Jawad, and M. A. Darwish. Desalination DSLNAH, Vol. 75, No. 1-3, p 97-116, 1989. 4 fig, 3 tab, 5 ref.

Descriptors: *Desalination, *Reverse osmosis, Seawater, Kimura-Sourirajan analysis, Comparison studies, Stavermann Coefficient, Hollow fiber membranes.

Reverse osmosis (RO) hollow fiber membranes are widely used in desalting seawater. The Kimura-Sourirajan analysis could be used successfully to predict the performance of this type of membrane. However, this method is lengthy, requires complicated calculations, and its transport equations do

Saline Water Conversion—Group 3A

not consider the selectivity of the membrane. Two modifications, to simplify the Kimura-Sourirajan analysis and to predict the performance of the RO hollow fiber membranes are presented. The first simplification takes advantage of insignificant concentration polarization in hollow fiber membranes to reduce its expression from an exponential to a linear form. This simplifies the calculations greatly with almost no loss of accuracy. The second modification introduces the selectivity coefficient (known as the Stavermann Coefficient) in the transport equation together with the previous simplification. The calculated results of the simplified analysis were compared with the calculated results of the original Kimura-Sourirajan analysis and showed close agreement. The characteristics information concerning the hollow fiber membranes are those of Du Pont B-10 Permapex. (Author's abstract) W90-05432

SYSTEM IDENTIFICATION AND CONTROL OF REVERSE OSMOSIS DESALINATION. Kuwait Inst. for Scientific Research, Safat. Petroleum, Petrochemicals and Materials Div. I. M. Alatiqi, A. H. Ghabris, and S. Ebrahim. Desalination DSLNAH, Vol. 75, No. 1-3, p 119-140, 1989. 12 fig, 4 tab, 7 ref.

Descriptors: *Desalination, *Reverse osmosis, Kuwait, Permeate flux, Conductivity, System identification, Relative gain array, Control, Feed pressure, Hydrogen ion concentration.

An efficient control system is the key point to successful long-term operation in any industry. In the reverse osmosis desalination process, various important parameters such as the permeate's flux and conductivity must be controlled. An effective closed loop control system is being developed for these parameters in a hollow fine fiber membrane system located at the research and development laboratory at Doha Reverse Osmosis Plant of Kuwait. Techniques used include: system identification, relative gain array and controllability tests to find best pairings and structure, Zeigler-Nichols settings to design single-input/single-output controllers for open loop systems, and, for the multi-variable system, the greatest log modulus tuning technique is implemented. The manipulated variables are feed pressure and pH, which control permeate flux and conductivity. The control system was simulated and satisfactory performance was obtained for set point tracking. (Author's abstract) W90-05433

COMPUTERIZED INSTRUMENTATION AND CONTROL FOR REVERSE OSMOSIS SYSTEMS. Reliable Water Co., Billerica, MA. E. Fredkin, and R. Banks. Desalination DSLNAH, Vol. 75, No. 1-3, p 141-148, 1989. 2 ref.

Descriptors: *Desalination, *Reverse osmosis, Computers, Design criteria, Canary Islands, Caribbean Sea, Control systems.

The concept and reality of the design of artificial intelligence computer software for the automatic operation and control of a seawater RO (reverse osmosis) plant are presented. A new and practical philosophy of methodology of artificial intelligence based software design, called 'machine instinct', is discussed in particular. Machine Instinct is based on several ideas, but is motivated by looking at how the most successful control systems on earth operate—namely the autonomous control of various processes in animals. The goal was to apply this sort of common sense and autonomous activity to the design of reverse osmosis systems. This software is used to control RO plants in the Canary Islands and in the Caribbean. The application of this technology to a 60,000 USGPD RO system presents the reality of this new plant control approach. (Author's abstract) W90-05434

ONE YEAR OPERATIONAL EXPERIENCE ON THE PROCESS CONTROL SYSTEM AT UANE MSF DESALINATION PLANT.

Italmimpianti S.p.A., Genoa. S. Rebagliati, E. Ghiazza, and K. S. Abueida. Desalination DSLNAH, Vol. 75, No. 1-3, p 149-169, 1989. 7 fig, 2 tab, 2 ref.

Descriptors: *Desalination, *United Arab Emirates, *Computers, *Control systems, Reliability, Safety.

A fully computerized Process Control System has been in operation for a year on desalination units 4, 5 and 6 at Umm Al Nar Power and Desalination Complex (Abu Dhabi, United Arab Emirates). An overall description of the system, which is based on two VAX 11/750 computers, and of its main features is presented together with some statistical data obtained during the first year of operation. Three typical plant operational cases are analyzed: (1) constant production, (2) load change operation, and (3) plant trip analysis. These cases show how the highest operation economy, reliability and safety is ensured by automatic control. (Author's abstract) W90-05435

ELECTROCHEMICAL MONITORING OF THE PROCESS OF BOILER CLEANING. Water and Electricity Dept., Abu Dhabi (United Arab Emirates). Material Testing Lab. A. M. Shams El Din, and A. M. K. Tag El Din. Desalination DSLNAH, Vol. 75, No. 1-3, p 171-184, 1989. 7 fig, 16 ref.

Descriptors: *Desalination, *Boilers, *Boiler cleaning, *Steel, Electrochemical potential, Temperature, Oxidation, Corrosion, Hydrogen peroxide, Sodium nitrite, Citric acid.

New boilers first introduced into service and old boilers coming from overhaul receive a cleaning process involving an acid wash and a surface passivation process. These processes are liable to affect the electrochemical potential of steel. It appeared of value to study this feature in detail with the aim of developing a simple direct procedure for monitoring the operation of boiler treatment. The conditions for obtaining a clean metal surface through treatment with citric acid solutions were examined and the effects of temperature, time of treatment and of surface oxidation on the open circuit potentials of steel samples were established. Passivation of the clean surface with hydrogen peroxide and sodium nitrite was studied and the threshold of concentration necessary for inhibition was determined. The stability of the passive films and their susceptibility to pitting attack by chloride ion were compared. The results clearly show that the whole process of boiler cleaning and preparation can be easily monitored electrochemically through potential measurements. This procedure overcomes the necessity of carrying out repeated chemical analysis and ensures simplicity, ease and savings in time and effort. (Author's abstract) W90-05436

MEASUREMENT OF LOCALIZED METAL REMOVAL IN PIPES BY GAMMA-RAY BACK-SCATTERING METHOD. King Abdulaziz Univ., Jeddah (Saudi Arabia). Coll. of Engineering. S. Abdul-Majid, and U. Dawood. Desalination DSLNAH, Vol. 75, No. 1-3, p 185-198, 1989. 5 fig, 23 ref.

Descriptors: *Desalination, *Pipelines, *Pipes, *Conveyance structures, Metal removal, Gamma-ray scanning, Leak detection.

Localized metal removal in pipes, especially those carrying liquid at high pressure, can make a hole causing a stream of the liquid to spray outside. Measuring the localized metal removal region before it develops to a hole will prevent this situation. In this method, which can be used to scan the pipe from the outside, a point gamma-ray source, and a high resolution portable Ge detector which is connected to a multi-channel analyzer are used. When the detector and the source are attached to the pipe wall, gamma photons will interact with the pipe material and some will back-scatter to the detector with lower energy than those of the pri-

mary photons. Therefore they will fall in a lower channel number and will not overlap with the primary ones. The amount of the back-scattered photons is proportional to the thickness of the pipe; thicker material will scatter more photons and vice-versa. The intensity will depend also on the photon energy and pipe material. In a localized metal removal region fewer photons will back-scatter to the detector and therefore the region can immediately be detected. Localized metal removal regions down to the mm range were measured. (Author's abstract) W90-05437

NEUTRON-CAPTURE GAMMA-RAY TECHNIQUE FOR SCALE IDENTIFICATION INSIDE PIPES. King Abdulaziz Univ., Jeddah (Saudi Arabia). Coll. of Engineering. S. Abdul-Majid, and U. Dawood. Desalination DSLNAH, Vol. 75, No. 1-3, p 199-210, 1989. 5 fig, 2 tab, 12 ref.

Descriptors: *Pipes, *Desalination, *Pipelines, *Conveyance structures, *Scaling, Scale detection, Neutron scanning, Germanium gamma detector, Calcium sulfate.

Identification of scale in desalination plant pipes from the outside without having to stop plant operation may have economic advantages. It is possible that scale could be removed while the plant is in operation by chemical means. A scale-detection technique in which neutrons from a neutron source such as $^{241}\text{Am}-^9\text{Be}$ are allowed to interact with the pipe material. Some of these neutrons are absorbed by the scale materials or by pipe material. Immediately after absorption they will emit gamma-ray photons which are characteristic of the materials. Their intensity will be proportional to the amount of scale while their energy will indicate the type of elements of the scale. A Ge gamma detector with a multichannel analyzer can be used for measuring the energy and intensity of these photons. By using this technique it was possible to identify calcium sulfate and other deposits. (Author's abstract) W90-05438

COMBINED RO/FREEZING SYSTEM TO REDUCE INLAND REJECTED BRINE. King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Mechanical Engineering. A. A. Madani, and S. E. Aly. Desalination DSLNAH, Vol. 75, No. 1-3, p 241-258, 1989. 5 fig, 2 tab, 17 ref.

Descriptors: *Desalination, *Reverse osmosis, *Brine disposal, *Direct contact freezing, Thermodynamics, Comparison studies, Energy costs, Mathematical equations.

A combined RO/DCF (reverse osmosis/direct contact freezing) system is proposed to reduce the problem of disposal of the brine rejected from inland desalination plants. Governing equations and thermodynamic relations are shown. Economic and energy comparisons between the combined system and separate RO and DCF units for 200 cu m/h are presented. Results show that the combined system can reduce the energy consumption by about 13 percent and 17 percent compared to separate RO and DCF plants. The combined system can reduce the rejected brine by over 90 percent of that of separate RO plant at the same water production. (Author's abstract) W90-05440

DESALINATION PLANT AT KWK DEBIENSKO, POLAND. Coal Union, Katowice, Poland. J. Masarczyk, C.-H. Hansson, R. L. Solomon, and B. Hallmans. Desalination DSLNAH, Vol. 75, No. 1-3, p 259-287, 1989. 1 fig, 4 tab.

Descriptors: *Desalination, *Reverse osmosis, *Poland, *Mine wastes, Vapor compression distil-

Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3A—Saline Water Conversion

lation, Crystallization, Sodium chloride drying, Drinking water.

The river water in Poland has, to a great extent, such a high salinity that it cannot be used as drinking water, agricultural or industrial water. A large environmental project is now in progress in Katowice, Poland, to eliminate the wastewater discharge from two coal mines. The highly brackish water will be desalinated in a reverse osmosis plant, followed by vapor compression distillation with seed crystals, crystallization and sodium chloride drying. This zero discharge process will produce about 8,000 cu m/d drinking water and 370 tons/d NaCl. The design of the plant is described. (Author's abstract)
W90-05441

POTENTIAL FOR WATER REUSE IN CONJUNCTION WITH DESALINATION SYSTEMS.
Ahlgren Associates, Waukegan, WI.
R. M. Ahlgren.
Desalination DSLNAH, Vol. 75, No. 1-3, p 315-328, 1989. 2 fig.

Descriptors: *Desalination, *Water reuse, *Wastewater renovation, Economic aspects, Filtration, Flotation, Disinfection, Chemical treatment, Package plants.

Pure water generated from desalination methods is comparatively costly and is used carefully and sparingly in those parts of world where desalination is an important part of water supply. Multiple use of water in these areas would be expected; however, combinations of technical, institutional, and economic barriers make the recycling of water very limited even in those areas of the world having almost critical needs. A good example of the potential for water recycling in conjunction with desalination is that of laundry water recycling at a major resort hotel. A packaged system designed expressly for purification of water from laundry operations was applied accomplishing a high percentage of water recycling and desalted water conservation together with excellent investment payout economics. The technology for accomplishing this water recycling utilizes chemical addition, dissolved air floatation, filtration, and final disinfection. Based on equipment investment and value of water recovered, cost of the equipment was recovered in less than 12 months of operation. This system and these process steps are just one of several approaches which can be designed to successfully recover water on a continuous and economic basis. Special processing steps can be added to accomplish higher levels of purification. Final oxidation technology such as ozonation can significantly enhance the ability of approaches such as this to produce water which is free of bacterial, virus, and trace organic contamination which might pose serious questions or even health hazards relevant to water reuse. (White-Reimer-PTT)
W90-05443

SKID MOUNTED MOBILE BRACKISH WATER REVERSE OSMOSIS PLANTS AT DIFFERENT SITES IN KUWAIT.
Administration of Water Desalination by RO, P.O. Box 12020 Shamiya, 71651 Shamiya, Kuwait.
A. L. A. Malik, N. G. Younan, B. J. R. Rao, and K. M. Mousa.
Desalination DSLNAH, Vol. 75, No. 1-3, p 341-361, 1989. 13 fig, 6 tab, 8 ref.

Descriptors: *Desalination, *Reverse osmosis, *Kuwait, *Water demand, Emergency planning, Skid Mounted Mobile Brackish Water Reverse Osmosis Units, Membranes, Biofouling.

In Kuwait, it has been realized that the storage of water to be used during emergencies will not be sufficient to meet water demand if the emergencies last for an unexpected period. This led to the idea of having small mobile Reverse Osmosis desalination units installed at various sites in the country. Consequently, specifications were developed for thirteen Skid Mounted Mobile Brackish Water Reverse Osmosis units of capacity 250,000 GPD. The units are identical in all aspects and utilize low

pressure membranes. The plants were distributed to the Labour Institute for Juveniles, Shuwaikh Storage area, two army camps and nine hospitals. The first plant (Labour Institute for Juveniles) was started on 13th February 1988, and has been running continuously, while the others are operated intermittently. The plants produce high-quality permeate (less than 100 mg/L total dissolved solids) at design capacity. During the first 8260 hours of operation of the first plant, no membrane element had been added or replaced. Other than the frequent change of cartridge filter elements due to biofouling, no other significant problems have been encountered. (White-Reimer-PTT)
W90-05445

PRE-TREATMENT AND DESALINATION OF MINE DRAINAGE WATER IN A PILOT PLANT.
Coal Union, Katowice, Poland.
J. Sikora, C.-H. Hansson, and B. Ericsson.
Desalination DSLNAH, Vol. 75, No. 1-3, p 363-378, 1989. 1 fig, 3 tab.

Descriptors: *Mine drainage, *Poland, *Reverse osmosis, *Desalination, Chemical treatment, Coagulation, Flocculation, Spiral wound composite membranes, Pilot studies.

A large environmental project is now in progress in Katowice, Poland, to eliminate the wastewater discharge from two coal mines. Chemical pre-treatment of the wastewater from these mines was first investigated on a laboratory scale. The purpose of this study was to solve the problems with RO (reverse osmosis) pre-treatment and to optimize the coagulation and flocculation conditions with respect to the turbidity and Silt Density Index (SDI) after sedimentation and filtration. The laboratory results are more favorable for spiral wound composite membranes, which accordingly have been recommended to be used in the full-scale plant. A pilot plant has been constructed for continuous operation of the pre-treatment and reverse osmosis with an influent flow of 2 cu m/h. The purpose of the trial operation, started up in the beginning of 1989, is primarily to investigate the influence of varying wastewater composition and loads on the pre-treatment based on the laboratory results. In the RO-section of the pilot plant two different spiral wound composite membranes are operated in parallel lines. (Author's abstract)
W90-05446

3B. Water Yield Improvement

OBSERVATIONS AND NUMERICAL SIMULATIONS OF PRECIPITATION DEVELOPMENT IN SEEDED CLOUDS OVER THE SIERRA NEVADA.
Wyoming Univ., Laramie.
For primary bibliographic entry see Field 7C.
W90-04599

EFFECTS OF CLOUD SEEDING IN WEST TEXAS.
Hebrew Univ. of Jerusalem (Israel). Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-04600

BAYESIAN INFERENCE APPLIED TO REAL-TIME RESERVOIR OPERATIONS.
Proctor and Red Group, St. Catharines (Ontario).
For primary bibliographic entry see Field 6A.
W90-05301

3C. Use Of Water Of Impaired Quality

GASTROINTESTINAL EFFECTS OF WATER REUSE FOR PUBLIC PARK IRRIGATION.
Houston Univ. at Clear Lake City, TX. Bureau of Research.
For primary bibliographic entry see Field 5B.
W90-04636

CROP PRODUCTION AND SEWAGE TREATMENT USING GRAVEL BED HYDROPONIC IRRIGATION.
Portsmouth Polytechnic (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-04742

GROUNDWATER INVESTIGATION OF SO4(2-) DIFFUSION FROM A CRETACEOUS SHALE HILLSLOPE: UPPER COLORADO RIVER BASIN.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5B.
W90-05234

PLANNING AND ANALYSIS FOR WATER REUSE PROJECTS.
California State Water Resources Control Board, Sacramento.
T. Asano, and R. A. Mills.
Journal of the American Water Works Association JAWWA, Vol. 82, No. 1, p. 38-47, January 1990. 8 fig, 2 tab, 8 ref.

Descriptors: *Water reuse, *Water resources management, *Water shortage, Project development, Public health, Economic aspects, Engineering.

Drought-induced water shortages and concern for long-term reliable water supplies are giving impetus to exploring innovative options for water supply. Water pollution control efforts have made available treated effluent, which can be an economical water supply compared with the increasing expense of developing new sources. Poorly conceived planning efforts, however, often lead to the rejection of worthwhile water reclamation and reuse projects or to the implementation of projects that will not achieve the intended goals. Although technical, environmental and social factors are considered in project planning, monetary factors tend to be the pivotal factors in deciding whether and how to implement a water reuse project. Monetary analyses fall into two categories: economic analysis and financial analysis. Other planning factors of particular significance in reclaimed-water project development are engineering and public health. Arriving at the optimum system design involves determination of the marginal or incremental costs of adding additional users and comparing those costs with the marginal benefit. Contracts need to address the concerns of the purveyor and the user and to clearly establish financial and operational responsibility and legal liability. (Author's abstract)
W90-05289

MUNICIPAL WASTEWATER RENOVATION BY REVERSE OSMOSIS STATE OF THE ART.
Kuwait Inst. for Scientific Research, Safat.
For primary bibliographic entry see Field 5D.
W90-05439

WASTEWATER RECLAMATION AND REUSE IN EUROPE, MIDDLE EAST AND NORTH AFRICA.
International Bank for Reconstruction and Development, Washington, DC. Europe, Middle East and North Africa Technical Dept.
A. A. Al-Khafaji, and D. A. Howarth.
Desalination DSLNAH, Vol. 75, No. 1-3, p 289-314, 1989. 4.2 charts.

Descriptors: *Water reuse, *Reclaimed water, *Arid climates, Wastewater utilization, Technology, Project planning, Economic aspects, Water quality management, Water resources management.

Middle East and North Africa countries together with Afghanistan and Pakistan and extensive zones in southern Europe, are characterized by an arid to semi-arid climate. There is considerable interest in the region on the subject of wastewater re-use. The technology that enables wastewater to be treated to different levels of purity exists and is well proven, so that treatment can be tailored to match

the intended use. Much of the scientific knowledge and monitored control of wastewater re-use has occurred in the last decade. The possible options from which choices have to be made to determine the optimum wastewater reuse scheme are many. This First Phase of a two phase study provides a review of the technical, public health, environmental, financial and economic criteria associated with wastewater re-use, together with the identification of a strategy that can be followed in the evaluation of a proposal for wastewater re-use. It has been prepared to be of assistance to countries and agencies concerned in the evaluation of wastewater reuse projects. (White-Reimer-PTT) 26 Jan 90 W90-05442

POTENTIAL FOR WATER REUSE IN CONJUNCTION WITH DESALINATION SYSTEMS. Ahlgren Associates, Waukasha, WI. For primary bibliographic entry see Field 3A. W90-05443

REUSE OF COLLECTED STORMWATER RUNOFF FOR IRRIGATION IN KUWAIT. Kuwaiti Tech Consultancy, P.O. Box 14342, Faiha, 72854, Kuwait. B. A. Al-Hoti, and R. Abdullah. Desalination DSLNAH, Vol. 75, No. 1-3, p 329-340, 1989. 3 fig, 3 tab, 15 ref.

Descriptors: *Desalination, *Water reuse, *Wastewater renovation, *Kuwait, *Storm wastewater, Irrigation practices, Groundwater, Brackish water, Water demand.

Kuwait is a small country, about 18,000 sq km in surface area, located at the northwest tip of the Persian Gulf. The country has only groundwater as a freshwater source, not enough for even drinking purposes. The government desalinates seawater to provide fresh water for human use. Brackish water is being used for irrigation purposes; this limits the number of crops grown and the surface area planted. Recently, the government has encouraged people to start planting trees in order to make Kuwait green. This will result in an increase in water demand for irrigation, especially in the summer months when the ambient temperature reaches about 50 C. Kuwait has a low yearly precipitation, which is collected in the developed areas in a stormwater drainage system and discharged into the Gulf. The amount of water collected in the stormwater drainage system would be sufficient to irrigate the developed areas of Kuwait during the hot summer months. Although the collected stormwater is contaminated with different polluting materials, the water can easily be treated by using a chemical precipitation process. (Author's abstract) W90-05444

3D. Conservation In Domestic and Municipal Use

WATER CONSUMPTION PATTERNS AMONG INDIVIDUALS IN CAPE TOWN. Cape Town Univ. (South Africa). Dept. of Community Health. For primary bibliographic entry see Field 6D. W90-04776

DROUGHT MANAGEMENT OF EXISTING WATER SUPPLY SYSTEM. Water Resources Management, Inc., Columbia, MD. For primary bibliographic entry see Field 5F. W90-05299

3F. Conservation In Agriculture

POLYMERS AS SOIL CONDITIONERS UNDER CONSECUTIVE IRRIGATIONS AND RAINFALL. California Univ., Riverside. Dept. of Soil and Environmental Sciences. M. Ben-Hur, M. Faris, M. Malik, and J. Letey.

Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1173-1177, July/August 1989. 4 fig, 16 ref.

Descriptors: *Irrigation effects, *Soil moisture deficiency, *Polymers, *Irrigation efficiency, *Soil amendments, *Soil absorption capacity, *Rainfall infiltration, Agricultural hydrology, Irrigation practices, Soil moisture retention, Infiltration, Sprinklers, Semiarid lands, Arid lands.

Low water infiltration caused by crust formation during rain or sprinkler irrigation is a significant problem in some arid and semi-arid regions. Polymers may be applied in irrigation water through a sprinkler system, but must be applied directly to the soil under rainfall conditions. A rainfall simulator study was conducted to: (1) determine the effect of drying of crusted vermiculitic soil on the subsequent crust properties and infiltration rate (IR) values; (2) determine the effect of polymers applied at low concentration in irrigation water of two qualities on the IR under consecutive water applications; and (3) determine the effectiveness of polymer application to the soil as would be required under rainfall conditions. Two cationic polysaccharide guar derivatives having a higher (HCCP) and a lower (LCCP) charge density and a polyacrylamide (PAM) with a low negative charge density were used in the study. Applications of polymers with the sprinkler water maintain IR in the order HCCP > LCCP > PAM > untreated. Except for PAM, the polymer applications were relatively ineffective in subsequent sprinkler applications with plain water applied with impact energy. The beneficial effects were preserved under water application without impact energy. Spraying concentrated polymer solutions on the soil surface was not effective in preventing crust formation by subsequent rain events except for the case when LCCP was sprayed on in a CaCl₂ solution. The results are explained on the basis of polymer adsorption and penetration into the soil surface layer and aggregates. (Author's abstract) W90-04623

ANTECEDENT RAINFALL AND TILLAGE EFFECTS UPON INFILTRATION. Minnesota Univ., St. Paul. Dept. of Soil Science. For primary bibliographic entry see Field 2G. W90-04624

SEVERAL SOURCES OF NONUNIFORMITY IN IRRIGATION DELIVERY FLOWS. Agricultural Research Service, Phoenix, AZ. Water Conservation Lab. J. D. Palmer, A. J. Clemmens, and A. R. Dedrick. Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 920-937, December 1989. 13 fig, 2 tab, 8 ref.

Descriptors: *Irrigation canals, *Flow rates, *Flow control, *Irrigation operation, *Water delivery, Hydraulics, Scheduling, Seasonal variation, Irrigation design, Farms.

A lateral canal in a southwestern U.S. irrigation district was instrumented for continuous monitoring. Deliveries were flexibly scheduled; farmers arranged timing, rate, and duration with the district. The distribution of measured variables showed that the lateral was operated under a wide variety of demand and operational conditions and that farm delivery flows were frequently not uniform due to changing conditions along the lateral. Flows that are unpredictably variable affect the performance and evaluation of on-farm application systems and, unless controlled, can negate the benefits of flexible scheduling (more precise management). Statistical analysis of 286 deliveries to 9 farm turnouts identified a number of sources of nonuniform flows which were a combination of canal hydraulics and operational characteristics. Time of year that deliveries occurred was shown to affect uniformity, as were median flow rate, delivery duration, and location of turnouts, both within a pool between two check structures and along the lateral. Identifying sources of nonuniformities is an important first step in devising structural and operational controls to improve uniformity. (Author's abstract)

W90-04815

IRRIGATION SCHEDULING MODEL WITH GROUNDWATER AND LIMITED ROOTING. Ahmadu Bello Univ., Zaria (Nigeria). Inst. for Agricultural Research, Irrigation Research Program. S. Abdulmumin. Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 938-953, December 1989. 7 fig, 3 tab, 32 ref.

Descriptors: *Soil-water-plant relationships, *Water table, *Irrigation operation, *Scheduling, *Mathematical models, *Root distribution, *Soil water, Darcy equation, Evapotranspiration, Wheat, Capillarity, Hydraulic conductivity, Irrigation efficiency.

An irrigation-scheduling model was developed based on soil-water budgeting, which incorporates the contribution of shallow-groundwater tables (GWT) to crop-water use and the effects of soil restrictions on crop rooting. Capillary flux of water from the groundwater table was estimated with a form of Darcy's equation, assuming mean soil water potential gradients between irrigations. Crop-water use was estimated with a grass-reference evapotranspiration and crop coefficients. Water uptake was partitioned into the contributions of various soil zones based on root distribution. The model inputs are: soil variables (available water, allowable depletion, GWT depth, moisture-characteristic curve, and unsaturated hydraulic conductivity); crop variables (root distribution); and climate). The model estimates irrigation interval, amount of water to apply per irrigation, and water contributed by the GWT. Scheduling the irrigation of wheat based on the model reduced seasonal irrigations by 28% and water application by 24% compared with the conventional weekly irrigation. (Author's abstract) W90-04816

MANAGEMENT MODEL FOR CONTROL OF ON-FARM IRRIGATION. Kansas State Univ., Manhattan. Dept. of Civil Engineering. J. C. Tracy, and M. A. Marino. Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 954-972, December 1989. 7 fig, 3 tab, 30 ref. Agricultural Research Service Cooperative Agreement 4350-H.

Descriptors: *Farm management, *Mathematical models, *Irrigation operation, *Irrigation requirements, Forecasting, Root development, Soil water, Crop yield, Cotton, Evapotranspiration, Simulation.

A physically based model for the management and forecasting of irrigation water requirements at an on-farm level is developed. The model includes mechanisms for simulating root and soil-water movement, root growth, and crop yield. Model inputs and soil and crop parameters are easily attainable so that the model is usable in field conditions. The management model is verified by calibrating it to a crop of cotton grown on an experimental plot at the University of California at Davis, then comparing the results of the model simulations to the field measured data for two alternate water treatments that were used to irrigate the experimental crop. These verifications indicate that the soil-water content distributions are simulated with a high degree of accuracy, and root-density distributions are better simulated under moist soil conditions. Further analysis indicates that maintaining moist soil conditions during the bloom stage of cotton growth is critical for consistently high crop yields. (Author's abstract) W90-04817

DYN2 METHOD FOR OPTIMAL CONTROL OF WATER FLOW IN OPEN CHANNELS. Automation and Telecommunications Inst., Belgrade (Yugoslavia). For primary bibliographic entry see Field 4A. W90-04818

Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3F—Conservation In Agriculture

ANALYTICAL MODEL FOR BORDER IRRIGATION.

Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
F. X. Yu, and V. P. Singh.
Journal of Irrigation and Drainage Engineering (ASCE) JIJDH, Vol. 115, No. 6, p 982-999, December 1989. 7 fig, 11 tab, 29 ref.

Descriptors: *Irrigation practices, *Irrigation engineering, *Border irrigation, *Mathematical models, Simulation, Performance evaluation, Flow profiles, Model testing.

This study develops a simple analytical model, using the volume balance approach, to simulate all phases of border irrigation. The surface and subsurface flow profiles in the advance phase are assumed to be of parabolic shape, and their coefficients are determined by conditions in the gradually varied flow region, rather than in the rapidly varied flow region near the advance front. The recession phases are simulated by using a simple iterative method based on Strelkoff's assumption, taking into account time-varying infiltration. Only one observed data set was used to calibrate the model, and 29 different observed data sets were used to verify the model. A comparison with some existing models shows that the model is simpler, more accurate (with less than 7% prediction error for all phases of the 29 test borders), and easier to apply. (Author's abstract)

W90-04819

EVAPOTRANSPIRATION IN SUDAN GEZIRA IRRIGATION SCHEME.

Hydraulics Research Station, Wad Medani (Sudan).
For primary bibliographic entry see Field 2D.
W90-04822

INVERTED V-NOTCH: PRACTICAL PROPORTIONAL WEIR.

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-04823

IRRIGATION IN NEPAL: OPPORTUNITIES AND CONSTRAINTS.

International Water Resources Association, Urbana, IL.
A. K. Biswas.
Journal of Irrigation and Drainage Engineering (ASCE) JIJDH, Vol. 115, No. 6, p 1051-1064, December 1989. 1 tab, 9 ref.

Descriptors: *Irrigation programs, *Nepal, *Groundwater potential, *Farm management, Economic development, Developing countries, International waters, Irrigation efficiency.

Agriculture accounts for nearly two-thirds of the gross domestic product of Nepal, one of the least developed countries of the world. Thus, irrigation is important to sustaining the country's economy. While irrigation has been practiced for decades, there is considerable need both to expand the currently irrigated area and to improve the efficiency of existing systems. There is no question that for the future economic development of an agrarian country like Nepal, irrigation development and management must play an important part. This paper reviews the potential of large-size to medium-size irrigation projects in the Terai, small-size irrigation projects in the hill areas, groundwater development, farmer-managed irrigation systems, and rehabilitation of existing irrigation projects. The role of irrigation as a means of expansion of production and income of the country and institutional implications is also discussed. It should, however, be noted that before major irrigation projects can be developed, treaties with India have to be negotiated for using the waters of international rivers. Thus, realistically, it is somewhat unlikely that major developments will occur before the year 2000. (Author's abstract)

W90-04824

AGRICULTURAL REQUIREMENT FOR IRRIGATION WATER.

R. J. Bailey, and J. Minihick.
Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 3, No. 5, p 451-458, October 1989. 1 fig, 8 tab, 13 ref.

Descriptors: *Irrigation water, *Irrigation requirements, *Crop production, *Computer programs, *England, *Wales, Soil types, Soil texture, Climates, Weather data collections, Irrigation efficiency, Quantitative analysis, Rainfall, Evapotranspiration.

A quantitative analysis of irrigation requirements in different climatic areas of England and Wales was made using a computer program developed jointly by the Agricultural Development and Advisory Service and the Meteorological Office. The program uses weather data from several hundred weather stations for 1961-1980. A balance sheet approach is used, with rainfall as a credit and evapotranspiration as a debit. For an overall view of irrigation requirement, farms were placed into categories of climate and soil type so that a set of data from each category could be extrapolated to a large number of farms. Climatic variation between years and localities, and the effects of soil and crop type on irrigation requirement were also taken into account when formulating the program. Tables were generated that make it possible to approximate irrigation requirements for a range of crops, grown in a range of soils, in each of the climatic areas studied. When using the program to estimate irrigation requirements for a given area, the economics of irrigation which are not included in the program should also be considered. (Geiger-PTT)

W90-05011

CANAL AUTOMATION PROVIDING ON-DEMAND WATER DELIVERIES FOR EFFICIENT IRRIGATION.

California Polytechnic State Univ., San Luis Obispo. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7B.
W90-05202

MOVEMENT OF PESTICIDES AND NUTRIENTS INTO TILE DRAINAGE WATER.

Purdue Univ., Lafayette, IN. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-05232

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

TEMPERATURE CHARACTERISTICS OF AN IMPOUNDED RIVER.

Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
R. W. Palmer, and J. H. O'Keeffe.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 4, p 471-485, 1989. 4 fig, 3 tab, 54 ref.

Descriptors: *Rivers, *Reservoirs, *Water temperature, *Flow discharge, *Dam effects, Downstream recovery, Buffalo River, South Africa.

Spatial and temporal changes in river water temperature were measured using maximum-minimum thermometers along the entire length (133 km) of the Buffalo River, eastern Cape, South Africa, a multiply impounded river. Impoundments cause a number of alterations to the temperature characteristics of the receiving river. The alterations of temperature depended primarily on the position of the impoundment along the river profile and the depth from which water was released. Greatest effects occurred during the warmer summer months. Downstream recovery was within 15 km during normal flow. Surface-release impoundments in the upper catchment increased maximum temperatures (by as much as 8 C), particularly in

summer. A surface-release impoundment in the middle reaches of the river had a slight dampening effect on river temperatures, while a bottom-release impoundment in the lower reaches of the river caused reductions in maximum temperatures of up to 16 C. A review of impoundment studies worldwide revealed a lognormal relationship between river discharge and downstream recovery. (Sand-PTT)

W90-04631

DYN2 METHOD FOR OPTIMAL CONTROL OF WATER FLOW IN OPEN CHANNELS.

Automation and Telecommunications Inst., Belgrade (Yugoslavia).
V. Filipovic, and Z. Milosevic.
Journal of Irrigation and Drainage Engineering (ASCE) JIJDH, Vol. 115, No. 6, p 973-981, December 1989. 2 fig, 15 ref, append.

Descriptors: *Open-channel flow, *Flow control, *Control systems, *Computer programs, *Water conveyance, *Water distribution, *Dynamic programming, Water delivery, Channels, Irrigation engineering, Pumping plants, Hydroelectric plants.

A new method for the optimal real-time control of water transport in open channels, called DYN2, is presented. This method was developed for controlling a class of water conveyance systems where so-called dynamic regulation (DR), proposed by the Societe du Canal de Provence (France), is the basic control method. The DR concept is based on the heuristic policy, which compensates for downstream cumulative volume error. In DYN2, however, optimal control theory is applied to solve the water-transport control problem more precisely than would be possible using the heuristic approach. Applying dynamic programming to DR, the DYN2 method was derived—thus the name DYN2. Both the DYN2 and DR were applied to the Strezevo irrigation system (southern Yugoslavia), resulting in the development of a state-of-the-art computer-based supervisory control and data acquisition system. In this system, a computer makes decisions based on either DR or DYN2 methods (depending on the operator's choice) and automatically controls system operations (closed-loop system). The objective is minimizing water loss and volume errors in canal reaches while meeting a number of constraints in the system. Since the problem of optimally controlling water transport systems is reduced to minimization of the optimality criterion, by employing DYN2 it would also be possible to state and solve more general problems. These might include not only optimally controlling water delivery systems but also pumping plants, generating plants, and other facilities in order ultimately to effect optimal control over the whole system. (Author's abstract)

W90-04818

WATER QUALITY INDEX FOR RIVER MANAGEMENT.

For primary bibliographic entry see Field 5G.
W90-04904

WHITE CART WATER FLOOD ALLEVIATION STUDY USING HYDRODYNAMIC MATHEMATICAL-MODELLING TECHNIQUES.

For primary bibliographic entry see Field 2E.
W90-04909

WATERWEED INVASIONS.

Toronto Univ. (Ontario). Dept. of Botany.
S. C. H. Barrett.
Scientific American SCAMAC, Vol. 261, No. 4, p 90-97, October 1989.

Descriptors: *Aquatic weeds, *Introduced species, *Water hyacinth, *Kariba weed, Canals, Irrigation ditches, Lakes, Aquatic weed control.

Vast vegetative mats of the two most noxious aquatic weeds plague the world's waterways. Investigations of the water hyacinth (*Eichhornia crassipes*) and the kariba weed (*Salvinia molesta*) are leading to new programs for weed control.

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Both the water hyacinth and the kariba weed have the ability to grow and multiply rapidly in habitats disturbed by humans, such as canals, irrigation systems, lakes and even rice fields. This article reviews the knowledge of species behavior in native and introduced ranges, and provides suggestions for managing the invading and problematic weeds. Some methods of control include introducing beetles that feed exclusively on kariba weed. Researchers are also studying the clonal propagation with the hopes of preventing reproduction of the water hyacinth and kariba weed. (Male-PTT) W90-04920

CLASSIFICATION OF WATER BEETLE ASSEMBLAGES IN ARABLE FENLAND AND RANKING OF SITES IN RELATION TO CONSERVATION VALUE.

West of Scotland Agricultural Coll., Auchincruive. Dept. of Environmental Sciences. For primary bibliographic entry see Field 2H. W90-04946

EXPRESSIONS RELATING PROBABILITY WEIGHTED MOMENTS TO PARAMETERS OF SEVERAL DISTRIBUTIONS INEXPRESSIBLE IN INVERSE FORM.

Chengdu Univ. of Science and Technology (China). For primary bibliographic entry see Field 7C. W90-05001

TAMING A RIVER WITH NEW TECHNOLOGY.

A. B. Smith. Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 3, No. 5, p 478-487, October 1989. 17 fig.

Descriptors: *Technology, *Aqueducts, *Water conveyance, *Artificial watercourses, *Water management, New River, Flow control, Labor, Weed control, Aquatic weeds, Bank stabilization, Telemetry, Monitoring, Water level fluctuations, Operating costs, Maintenance, Dredging, Administrative agencies.

In response to requirements of the Thames Water Authority for improved efficiency on all aspects of river management, methods for reducing the overall unit cost, reducing labor, and improving service for the New River were initiated. The management of the New River was transferred from the Metropolitan Water Division to the new Eastern Division. The re-organization in 1982 coincided with a major Authority objective in introducing WIPPS (Water Industry Productivity Payment Scheme) with substantial manpower reductions across all functions. Physical constraints of the river made it necessary to bring in special mini-equipment, amphibious equipment and floating equipment to perform routine maintenance operations on the river. Originally hand tools such as the scythe, beater, and chain knife were used for aquatic weed control along the channel of the New River. The labor force was reduced from 88 employees to 45 employees and one full-time manager over a six month period. The remaining employees were trained to operate new equipment such as weed cutting boats, and automatic weed screen cleaners. A low-level floating excavator was designed and used for silt removal. Unsinkable punts were introduced for clay transport for improving bank stability. A new method of revetting which involves shoring up the bank using three meter lengths of trench sheetpiles was introduced. This sheeting forms an effective barrier against animal and water movement. New embankment mowers capable of operating on a 45 degree angle were adopted for grass cutting along the banks. Flow monitoring was accomplished by use of a new telemetry system. Daily patrols were initiated with patrolmen using portable telephones to improve communication and decrease response time for problem solving. (Geiger-PTT) W90-05015

DEVELOPING AND MANAGING A COMPREHENSIVE RESERVOIR ANALYSIS MODEL.

Hydrologic Engineering Center, Davis, CA. For primary bibliographic entry see Field 6A. W90-05182

FLOOD OF SEPTEMBER 7-9, 1987, IN LEXINGTON AND RICHLAND COUNTIES IN THE VICINITY OF SAINT ANDREWS ROAD AND IRMO, SOUTH CAROLINA.

Geological Survey, Columbia, SC. Water Resources Div. For primary bibliographic entry see Field 2E. W90-05188

HYDROLOGIC EVALUATION AND WATER SUPPLY CONSIDERATIONS FOR FIVE PAIUTE INDIAN LAND PARCELS, MILLARD, SEVIER, AND IRON COUNTIES, SOUTHWESTERN UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div. For primary bibliographic entry see Field 2F. W90-05189

HYDRAULIC CHARACTERISTICS OF THE NEW RIVER IN THE NEW RIVER GORGE NATIONAL RIVER, WEST VIRGINIA.

Geological Survey, Charleston, WV. For primary bibliographic entry see Field 2E. W90-05191

FLOOD BOUNDARIES AND WATER-SURFACE PROFILE FOR THE COMPUTED 100-YEAR FLOOD, SWIFT CREEK AT AFTON, WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div. For primary bibliographic entry see Field 7C. W90-05192

CANAL AUTOMATION PROVIDING ON-DEMAND WATER DELIVERIES FOR EFFICIENT IRRIGATION.

California Polytechnic State Univ., San Luis Obispo. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 7B. W90-05202

LOW-FLOW CHARACTERISTICS OF STREAMS IN WEST VIRGINIA.

Geological Survey, Charleston, WV. Water Resources Div. For primary bibliographic entry see Field 2E. W90-05203

ESTIMATES OF MEAN MONTHLY STREAM-FLOW FOR SELECTED SITES IN THE MUSSELSHELL RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1937-86.

Geological Survey, Helena, MT. Water Resources Div. For primary bibliographic entry see Field 2E. W90-05267

BAYESIAN INFERENCE APPLIED TO REAL-TIME RESERVOIR OPERATIONS.

Proctor and Red Group, St. Catharines (Ontario). For primary bibliographic entry see Field 6A. W90-05301

OPTIMIZING SPILLWAY CAPACITY WITH UNCERTAINTY IN FLOOD ESTIMATOR.

California Univ., Davis. Dept. of Land, Air and Water Resources. For primary bibliographic entry see Field 2E. W90-05303

LIPID SYNTHESIS BY ISOLATED DUCK-WEED (LEMNA MINOR) CHLOROPLASTS IN THE PRESENCE OF A SUBLETHAL CONCENTRATION OF ATRAZINE.

Sherbrooke Univ. (Quebec). Dept. de Biologie. G. Grenier, L. Proteau, and G. Beaumont. Canadian Journal of Botany CJBOW, Vol. 67,

No. 8, p 2261-2265, August 1989. 3 tab, 30 ref.

Descriptors: *Herbicides, *Duckweed, *Laboratory methods, *Aquatic weeds, *Aquatic weed control, Photosynthesis, Aquatic plants, Atrazine.

The effects of a sublethal concentration of atrazine on the incorporation of sodium-(U-14C) acetate into isolated chloroplast lipids of Lemna minor was examined. A high level of (14C)-acetate was incorporated into diacylgalactosylglycerol (DGG) and diacylglycerol (DAG). Consequently, the conversion of phosphatidic acid to DAG and that of DAG to DGG seems to be as active in L. minor (an '18:3-plant') as in '16:3-plants'. Chloroplast lipids from atrazine-treated plants were more extensively labelled with (14C)-acetate than the control plants. These results are in agreement with previous *in vivo* studies which suggest that sublethal concentrations of atrazine stimulate the lipid metabolism of L. minor to form more thylakoid membranes. The specific radioactivity of linoleic acid was the highest in DAG and the lowest in DGG. These data suggest that desaturation of linoleic acid to linolenic acid mainly occurs before the galactosylation of DAG to form DGG in L. minor. (Author's abstract) W90-05351

WATER AND MASS EXCHANGE IN THE LAKE BAIKAL AND STORAGE RESERVOIRS OF THE ANGARA CASCADE.

Limnologicheskii Inst., Irkutsk (USSR). For primary bibliographic entry see Field 2H. W90-05455

MODELLING INTERNAL AND EXTERNAL CONTROL IN LAKE AND RESERVOIR ECOSYSTEMS.

Ceskoslovenska Akademie Ved, Prague. Ustav Teorie Informace a Automatizace. For primary bibliographic entry see Field 2H. W90-05472

INFLUENCE OF RESERVOIRS ON THE HYDROLOGICAL REGIME OF THE KUR RIVER.

Akademiya Nauk Azerbaizdzhanskoi SSR, Baku. Inst. of Geography. H. I. Fatullayev. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 215-217, November 1989.

Descriptors: *Flow control, *Reservoirs, *Rivers, *Flow discharge, *Kur River, Economic aspects, Fisheries, Silt load, Suspended sediments, Sediment load.

The hydrologic regime of the Kur river (USSR), the basin of which occupies the main part of the more developed territories of the Transcaucasian Republics, has been exposed to the influence of various economic factors, the primary impact being that of bed regulation. During the last 35 years, about 50 reservoirs, with a total area of more than 1000 sq km, have been constructed and exploited in the river basin. These reservoirs have had an influence on the Kur river regime. The Mingechir reservoir in particular has radically changed the hydrological regime of the river and hence the pre-construction period may be called the conditional-natural one. The least annual discharge before construction of the Mingechir reservoir at Mingechir city and Sabirabad city was 61 and 109 cu m/sec, respectively. After construction of the reservoir these indices increased to 65 and 138 cu m/sec. In contrast to the conditional-natural period, in many cases in the disturbed period the minimal discharge frequently exceeds 140 cu m/sec, providing necessary water inflows for the demands of fisheries and water transport. Analysis of the integral curves of monthly flow in the reaches of the river at Sabirabad showed that with the construction of the reservoir radical changes occurred in the yearly distribution of the flow. As a result of the impact of complex economic factors on the flow, its monthly volume in the spring-summer flood is highly reduced. In August, September, December, January and March the flow is considerably increased; there is no signifi-

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Group 4A—Control Of Water On The Surface

cant change in November. Calculation of the annual distribution of the flow within the two periods (1933-1952 and 1953-1984) substantiated the considerable change in the annual distribution of the flow due to the influence of a wide range of national economic factors. The reservoirs also have an influence on the regime of silt load and sediment. Analyses of the disturbed period reveal a tendency towards a fluctuation of flow sediments and silt load as a result of the realization of complex water economic measurements on the Kur river basin. (Sand-PTT)
W90-05474

PRACTICAL APPROACHES TO RIPARIAN RESOURCE MANAGEMENT: AN EDUCATIONAL WORKSHOP.

For primary bibliographic entry see Field 6A.
W90-05491

SELLING A SUCCESSFUL RIPARIAN MANAGEMENT PROGRAM: A PUBLIC LAND MANAGER'S VIEWPOINT.

Bureau of Land Management, Prineville, OR. Prineville District Office.
J. L. Hancock.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 1-3.

Descriptors: *Land use, *Land management, *Water resources management, *Water law, *Management planning, *Riparian waters, *Riparian land, Stream erosion, Stream stabilization, Streamflow, Stream degradation, Stream improvement, Streams, Legal aspects, Grazing, Riparian rights, Oregon, Wildlife management.

Management of riparian areas is a key issue facing land managers today. A major challenge for the manager is selling an effective riparian area management program to public land users, interest groups, and private landowners whose holdings are intermingled with public lands throughout the west. A successful program developed in central Oregon during the past 10 years is based upon six major steps: (1) identifying benefits derived from proper riparian management (clean water, more uniform stream flows, less soil erosion, increased livestock forage, and improved wildlife habitat), (2) having access to an 'on-the-ground' recovered riparian area accomplished through grazing management, (3) bringing 'key players' (affected landowners and permittees, interest group members, agency personnel, and public land managers) together 'on-the-ground' to agree on goals, alternatives and a plan of action, (4) closely monitoring progress in reaching goals, (5) keeping all parties involved and communicating, (6) remaining flexible to changes needed to make the program work. In summary, a strong coalition of land users, landowners, and managers working together on commonly identified goals is the key to selling a successful riparian management program. (See also W90-05491) (Author's Abstract)
W90-05492

OREGON WATERSHED IMPROVEMENT COALITION'S APPROACH TO RIPARIAN MANAGEMENT.

Oregon Watershed Improvement Coalition, Burns. Education Committee.
M. L. Hanson.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 5-6. 2 ref.

Descriptors: *Land use, *Land management, *Water resources management, *Water law, *Riparian waters, *Riparian land, *Oregon, Oregon Watershed Improvement Coalition, *Range management, Streams, Stream improvement, Environmental protection, Environmental policy, Management planning, Watersheds.

The Oregon Watershed Improvement Coalition (OWIC) is a unique coalition of ranchers, environmentalists, and range specialists dedicated to improving communications between its member

groups and improving riparian ecological conditions in Oregon's rangeland environment. Formed in 1986, the Oregon Watershed Improvement Coalition has developed, through a consensus process, specific objectives to meet its goal of insuring the long term benefits of riparian areas and their associated uplands. To achieve its objectives, the Coalition is sponsoring a project in the Bridge Creek Watershed in central Oregon. The purpose of the project is to build and involve a local coalition of land owners in the decision-making and site specific problem-solving processes, and to demonstrate that changes in management can achieve desired goals in riparian and upland conditions. (See also W90-05491) (Author's abstract)
W90-05493

NEW APPROACH TO RIPARIAN MANAGEMENT IN WASHINGTON STATE.

Washington State Dept. of Fisheries, Olympia.
D. E. Phinney, M. S. Deussen, S. M. Keller, and P. A. Knudsen.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 11-15. 7 ref, append.

Descriptors: *Land management, *Water resources management, *Water law, *Washington, *Management planning, *Riparian land, *Riparian waters, *Riparian rights, *Environmental protection, *Environmental policy, Negotiations, Remedies, Legal aspects, Timber Fish and Wildlife Agreement, Land management, Logging.

The 1974 State Forest Practices Act regulates forest practices on state and private forest lands in Washington to protect public resources and maintain a viable timber industry. As successive revisions of the regulations were adopted, new conflicts between the industry, tribes, environmentalists, and state agencies arose. When riparian management regulations were proposed in 1986, rampant controversy erupted. Industry representatives claimed economic bankruptcy; fish and wildlife advocates called the proposals inadequate. As a result, several individuals sought to improve forest practices regulation, especially riparian area management. With the assistance of a nonprofit corporation, representatives of all interests were brought into a negotiating forum. After four months of intensive effort, agreement was reached that had unanimous endorsement. The Timber, Fish, and Wildlife Agreement is noteworthy not only for the unique way it was accomplished, but also for the results achieved. Riparian management requirements with increased resource protection were established. The new approach gives flexibility to loggers and still achieves resource protection. The Timber, Fish, and Wildlife Agreement incorporates framework and procedures that will assure the regulations remain current. (See also W90-05491) (Author's abstract)
W90-05494

INTEGRATION OF RIPARIAN DATA IN A GEOGRAPHIC INFORMATION SYSTEM.

Willamette National Forest, Eugene, OR.
For primary bibliographic entry see Field 7C.
W90-05495

USE OF HYDROLOGY IN RIPARIAN CLASSIFICATION.

Bureau of Land Management, Boise, ID. Idaho State Office.
For primary bibliographic entry see Field 7B.
W90-05500

MANAGEMENT OF WINTER SOIL TEMPERATURES TO CONTROL STREAMBANK EROSION.

Nevada Univ., Reno. Dept. of Range, Wildlife and Forestry.
For primary bibliographic entry see Field 4D.
W90-05502

COMPATIBILITY OF LIVESTOCK GRAZING STRATEGIES WITH FISHERIES.

Intermountain Forest and Range Experiment Station, Boise, ID. Forestry Sciences Lab.
For primary bibliographic entry see Field 4D.
W90-05506

RESPONSE OF A SOUTHWEST MONTANA RIPARIAN SYSTEM TO FOUR GRAZING MANAGEMENT ALTERNATIVES.

Montana State Univ., Bozeman. Dept. of Animal and Range Sciences.
For primary bibliographic entry see Field 4D.
W90-05507

GRAZING AND RIPARIAN MANAGEMENT IN SOUTHWESTERN MONTANA.

Bureau of Land Management, Dillon, MT.
For primary bibliographic entry see Field 4D.
W90-05508

STREAMSIDE ZONES AND WILDLIFE IN SOUTHERN U.S. FORESTS.

Southern Forest Experiment Station, Nacogdoches, TX. Wildlife Habitat Lab.
J. G. Dickson.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 131-133. 1 tab, 15 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Riparian land, *Riparian vegetation, *Animal populations, *Forest watersheds, *Wildlife habitats, *Ecology, Species diversity, Amphibians, Reptiles, Squirrels, Stream profiles.

Strips of mature trees, retained along intermittent streams when stands are harvested and planted to pine, reduce effects of nonpoint pollution and enhance wildlife habitat. The Southern Forest Experiment Station is investigating the effects of extent and composition of streamside zones on vertebrate wildlife communities in pine forests in southern USA. Specifically, relative animal abundance was related to narrow (7-23 m), medium (31-40 m), and wide (52-93 m) stream zones. Virtually no squirrels or squirrel nests were found in stream zones less than 40 m wide but were common in those greater than 50 m wide. Amphibians and reptiles were abundant in medium and wide stream zones (wider than 30 m), which were characterized by a canopied overstory, shaded understory, and leaf litter. Amphibians and reptiles were low in abundance in the dense brushy narrow zones with logging slash, but this habitat supported the highest abundance of small mammals. (See also W90-05491) (Author's abstract)
W90-05510

REHABILITATING DEPLETED RIPARIAN AREAS USING CHANNEL STRUCTURES.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ.
For primary bibliographic entry see Field 4D.
W90-05512

SIMULATION MODEL FOR MANAGING FISHERIES IN RESERVOIRS ON THE RIO GRANDE OF NEW MEXICO.

New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
For primary bibliographic entry see Field 8I.
W90-05515

EFFECT OF A HYPOLIMNETIC DISCHARGE ON REPRODUCTIVE SUCCESS AND GROWTH OF WARMWATER FISH IN A DOWNSTREAM IMPOUNDMENT.

Tennessee Valley Authority, Norris. Office of Natural Resources.
For primary bibliographic entry see Field 8I.
W90-05530

WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

Effects On Water Of Man's Non-Water Activities—Group 4C

SIMULATION OF RAINFALL-RUNOFF RESPONSE IN MINED AND UNMINED WATERSHEDS IN COAL AREAS OF WEST VIRGINIA.

C. Puente, and J. T. Atkins.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2298, 1989. 48p, 30 fig, 7 tab, 26 ref, append.

Descriptors: *Small watersheds, *Simulation analysis, *Rainfall-runoff relationships, *Coal mines, *West Virginia, Drawdy Creek, Runoff, Hydrologic models, Model studies, Interbasin transfers, Surface-groundwater relations, Flow discharge.

Meteorologic and hydrologic data from five small watersheds in coal areas of West Virginia were used to calibrate and test the US Geological Survey Precipitation-Runoff Modeling System for simulating streamflow under various climatic and land-use conditions. Three of the basins—Horsecamp Run, Gilmer Run, and Collision Creek—are primarily forested and relatively undisturbed. The remaining basins—Drawdy Creek and Brier Creek—are extensively mined, both surface and underground above stream drainage level. Model simulations of the water budgets for the unmined basins during the 1972-73 water years indicate that total annual runoff averaged 60% of average annual precipitation; annual evapotranspiration losses averaged 40% of average annual precipitation. Of the total annual runoff, approximately 91% was surface and subsurface runoff and 9% was groundwater discharge. In contrast, water budget simulations for the mined basins indicate significant differences in annual recharge and in total annual runoff. Model simulations of the water budget for Drawdy Creek basin indicate that total annual runoff during 1972-73 averaged only 43% of average annual precipitation—the lowest of all study basins; annual evapotranspiration losses averaged 49%, and interbasin transfer of groundwater losses averaged about 8%. Of the total annual runoff, approximately 74% was surface and subsurface flow and 26% was groundwater discharge. The low total annual runoff at Drawdy Creek probably reflects increased recharge of precipitation and surface and subsurface flow losses to groundwater. Most of the increase in groundwater storage is, in turn, lost to a groundwater sink—namely interbasin transfer of groundwater by gravity drainage and/or mine pumpage from underground mines that extend to adjacent basins. Hypothetical mining situations were posed for model analysis to determine the effects of increased mining on streamflow in the mined basins. Results of model simulations indicate that streamflow characteristics, the water budget, and the seasonal distribution of streamflow would be significantly modified in response to an increase in mining in the basins. (Lantz-PTT) W90-05560

4B. Groundwater Management

ANALYSIS OF THE EFFECT OF PUMPING ON GROUND-WATER FLOW IN THE SPRINGFIELD PLATEAU AND OZARK AQUIFERS NEAR SPRINGFIELD, MISSOURI.

Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2F. W90-05218

HYDROLOGIC EFFECTS OF PUMPAGE FROM THE DENVER BASIN BEDROCK AQUIFERS OF NORTHERN EL PASO COUNTY, COLORADO.

Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2F. W90-05219

WATER-LEVEL CHANGES IN THE HIGH PLAINS AQUIFER UNDERLYING PARTS OF SOUTH DAKOTA, WYOMING, NEBRASKA, COLORADO, KANSAS, NEW MEXICO, OKLAHOMA, AND TEXAS—PREDEVELOPMENT THROUGH NONIRRIGATION SEASON 1987-88.

Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2F. W90-05220

PROCEDURE FOR EVALUATING OBSERVATION-WELL NETWORKS IN WYOMING, AND APPLICATION TO NORTHEASTERN WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7A. W90-05276

AQUIFER TESTS IN THE FLOOD-PLAIN ALLUVIUM AND SANTA FE GROUP AT THE RIO GRANDE NEAR CANUTILLO, EL PASO COUNTY, TEXAS.

Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F. W90-05283

HYDROGEOLOGY AND SIMULATED EFFECTS OF GROUND-WATER DEVELOPMENT OF THE FLORIDAN AQUIFER SYSTEM, SOUTHWEST GEORGIA, NORTHWEST FLORIDA, AND SOUTHERNMOST ALABAMA.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2F. W90-05562

4C. Effects On Water Of Man's Non-Water Activities

PLAYA LAKES: PRAIRIE WETLANDS OF THE SOUTHERN HIGH PLAINS.

North Carolina Univ. at Wilmington.
For primary bibliographic entry see Field 2H. W90-04555

DEAD SEA SURFACE-LEVEL CHANGES.

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2H. W90-04559

RAINFALL TIME SERIES FOR STORM OVERFLOW ASSESSMENT.

Water Research Centre, Swindon (England). Swindon Engineering Centre.
For primary bibliographic entry see Field 2B. W90-04772

TROPICAL DEFORESTATION TRIGGERS ECOLOGICAL CHAIN REACTION.

Water Environment and Technology, Alexandria, Virginia.
A. B. Nichols.
Water Environment and Technology, Vol. 1, No. 2, p 320-327, October 1989.

Descriptors: *Dams, *Deforestation, *Climates, *Erosion, *Siltation, *Land use, *Environmental effects, Tropical regions.

Deforestation of the world's tropical forests is happening at alarming rates. The ecological implications of cutting down and burning so many trees are environmental and political issues. Here, the effects of deforestation—climate changes and unbalanced ecosystems—are described. Erosion, loss of windbreaks, reduced animal habitats, disrupted groundwater regulation and upset nitrogen cycle are just some of the problems attributed to deforestation. Dams are both a cause and a victim of deforestation. They are readily silted in as a result of deforestation and also cause flooding which leads to further erosion and sedimentation. Two glaring examples of misguided development projects that have harmed the forest are the Balbina Dam in the Amazon basin and the Sardar

Sarovar Dam in the Indian state of Gujarat. (Male-PTT) W90-04881

WINTER ABUNDANCE OF CHANNEL CATFISH IN THE CHANNELIZED MISSOURI RIVER, NEBRASKA.

Nebraska Game and Parks Commission, Lincoln.
For primary bibliographic entry see Field 2H. W90-04916

METHODS OF EVALUATING THE RELATIONSHIP OF GROUND-WATER QUALITY TO LAND USE IN A NEW JERSEY COASTAL PLAIN AQUIFER SYSTEM.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5A. W90-05105

RELATIONS BETWEEN LAND USE AND WATER QUALITY IN THE HIGH PLAINS AQUIFER OF SOUTH-CENTRAL KANSAS.

Geological Survey, Lawrence, KS.
For primary bibliographic entry see Field 5B. W90-05107

STATISTICAL COMPARISON OF GROUND-WATER QUALITY IN FOUR LAND-USE AREAS OF STRATIFIED-DRIFT AQUIFERS IN CONNECTICUT.

Geological Survey, Hartford, CT.
For primary bibliographic entry see Field 5B. W90-05111

URBAN LAND POLICY: SELECTED ASPECTS OF EUROPEAN EXPERIENCE.

Department of Housing and Urban Development, Washington, DC. Office of International Affairs.
P. F. Patman, R. J. Burroughs, E. J. Howenstine, S. E. Smigel, and Z. K. Szczepanski.
Department of Housing and Urban Development, Washington, DC. Report No. HUD-94-SF, March 1969. 219p, 7 tab, 76 ref.

Descriptors: *Europe, *Public policy, *Urbanization, *Land use, History, Management planning, Economic aspects.

This report surveys certain facets of European urban land policy, and is a second study on foreign developments in the fields of housing, building and planning. The general historical, cultural and environmental setting in which European land policy developed is reviewed in Chapter 1. Chapter 2 discusses the growing scarcity of urban land in Europe, and the actions taken by European governments. Chapter 3 focuses briefly on European physical planning principles and processes, and their increasingly close relationships with economic planning. It also examines the methods used to carry out such planning to achieve more socially and economically desirable land use. Chapter 4 reviews the available data on major European growth patterns, and considers the comparative costs of alternative forms of urban expansion. The role played by infrastructure as a tool of urban land policy, with particular attention to the development of urban centers in economically lagging areas, is examined in Chapter 5. Chapter 6 summarizes and comments on the lessons learned from European experience. (Lantz-PTT) W90-05138

CHEMICAL CHARACTERISTICS, INCLUDING STABLE-ISOTOPE RATIOS, OF SURFACE WATER AND GROUNDWATER FROM SELECTED SOURCES IN AND NEAR EAST FORK ARMELLS CREEK BASIN, SOUTHEASTERN MONTANA, 1985.

Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 2K. W90-05204

Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

Group 4C—Effects On Water Of Man's Non-Water Activities

EFFECTS OF AGRICULTURAL PRACTICES AND SEPTIC-SYSTEM EFFLUENT ON THE QUALITY OF WATER IN THE UNCONFINED AQUIFER IN PARTS OF EASTERN SUSSEX COUNTY, DELAWARE.

Delaware Geological Survey, Newark.

J. M. Denver.

Available from Delaware Geological Survey, University of Delaware, Newark, DE 19716. Report of Investigations No. 45, June 1989. 66p, 21 fig, 5 tab, 26 ref, append.

Descriptors: *Land use, *Water pollution sources, *Nitrates, *Unconfined aquifers, *Water quality, *Fertilizers, *Septic wastewater, *Groundwater pollution, *Delaware, Agricultural irrigation, Land use, Groundwater movement, Groundwater recharge, Chemical reactions, Natural waters, Atlantic Coastal Plain.

The unconfined aquifer in eastern Sussex County, Delaware consists mainly of quartz sand and gravel; its shallow water table is susceptible to contamination by nitrate and other chemical constituents associated with agricultural practices and septic-system effluent. The distribution and movement of nitrate and other fertilizer components were studied by measuring water levels and by collecting and analyzing groundwater samples from piezometers screened at various depths around a 220-acre irrigated field. There is a direct relation between concentrations of nitrate and specific conductance. Therefore, specific conductance was used to estimate nitrate concentrations in water samples and to indicate the degree of agricultural influence on water chemistry. Factors including upgradient land use, groundwater pumping, fertilizer application rates, magnitude and timing of recharge, and heterogeneous aquifer properties affect the distribution of agricultural chemicals in the aquifer. Concentrations of nitrate ranged from less than 2 to greater than 40 mg/L. Although chemical constituents associated with agriculture generally decreased with depth in the aquifer, nitrate (as nitrogen) concentrations were as high as 29 mg/L near the base of the aquifer. Eleven wells where water quality is affected solely by septic-system effluent were located and sampled. The chemical components of septic-system effluent also are present in manures, fertilizers, and pesticides, and their presence cannot be used to identify uniquely the source of groundwater contamination. (USGS)

W90-05209

INVENTORY AND EVALUATION OF BIOLOGICAL INVESTIGATIONS THAT RELATE TO STREAM-WATER QUALITY IN THE UPPER ILLINOIS RIVER BASIN OF ILLINOIS, INDIANA, AND WISCONSIN.

Geological Survey, Denver, CO. Water Resources Div.

For primary bibliographic entry see Field 5C. W90-05224

VARIATIONS IN RESERVOIR SEDIMENTATION IN SCOTLAND IN RESPONSE TO LAND USE CHANGES.

Saint Andrews Univ. (Scotland). Dept. of Geography.

For primary bibliographic entry see Field 2J. W90-05453

EVALUATION OF THE U.S. FOREST SERVICE 'COWFISH' MODEL FOR ASSESSING LIVESTOCK IMPACTS ON FISHERIES IN THE BEAVERHEAD NATIONAL FOREST, MONTANA.

Montana Dept. of Fish, Wildlife and Parks, Helena.

B. B. Shepard.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 23-33. 2 fig, 5 tab, 28 ref.

Descriptors: *Environmental impact, *Land management, *Water resources management, *Water law, *Trout, *Fish populations, *COWFISH model, *Model studies, *Stream fisheries, *Graz-

ing, *Montana, *Range management, Streams, Stream biota, Streamflow, Stream gradient, Fish, Aquatic habitats.

The COWFISH fish habitat model developed by the U.S. Forest Service was evaluated during 1986 and 1987 at 43 stream sites within the Beaverhead National Forest, Montana to determine the ability of the model to assess effects of livestock grazing on trout fisheries. The COWFISH model uses a field survey of five variables (percentage of streambank with overhanging vegetation, percentage embeddedness, percentage of the streambank undercut, percentage of the streambank in an altered condition, and width:depth ratio) in association with channel gradient and the presence or absence of granitic parent material within the drainage to predict optimum and existing numbers of catchable (152 mm total length and longer) trout. The model predicted reasonable estimates of catchable cutthroat trout *Oncorhynchus clarki*, rainbow trout *O. mykiss*, and hybrids of these species at 19 sites where one or more of these forms occurred; however, predicted numbers of catchable brook trout *Salvelinus fontinalis* were imprecise at the 26 sites containing brook trout. Habitat suitability index results for field data collected by different observers did not appear to be significantly different, and results for sites that deviated from model site criteria were not significantly different from sites that met site criteria. Minor modifications in the model appeared to slightly improve model performance. Use of the COWFISH model by range professionals and livestock permittees did increase their awareness of the effects of livestock grazing on aquatic resources. (See also W90-05491) (Author's abstract) W90-05496

MITIGATION MEASURES RECOMMENDED IN CONNECTICUT TO PROTECT STREAM AND RIPARIAN RESOURCES FROM SUBURBAN DEVELOPMENT.

Connecticut Dept. of Environmental Protection, Marlborough. Bureau of Fisheries.

B. D. Murphy, and C. L. Phillips.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 35-39. 2 fig, 1 tab, 16 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Riparian waters, *Riparian land, *Urban planning, *Connecticut, *Environmental protection, Riparian rights, Legal aspects, Environmental policy, Trout, Stream degradation, Stream biota, Stream pollution, Erosion, Water pollution prevention.

Accelerating suburban development in eastern Connecticut threatens to degrade valuable stream and riparian zone habitat. A representative case was the proposed construction of a large condominium complex along the Hop River, an important trout stream. An environmental assessment was requested by local officials to delineate impacts of residential development on the Hop River and recommend feasible mitigation measures. The following impacts were anticipated: (1) elimination of mixed hardwood-shrub riparian habitat, (2) soil erosion and sedimentation, and (3) percolation of heated, fertile septic effluent into the River. Cumulatively, these impacts will result in reduced trout and macroinvertebrate production as well as water quality degradation. Recommended mitigation measures were: (1) protect riparian zone habitat by maintaining a 30-m buffer along each side of the river; this buffer width is desirable due to site slopes greater than 15% and erodible soils, (2) install erosion and sedimentation controls during construction; controls include a filter fabric sediment fence, staked hay bales, and sediment detention basin, and (3) properly locate the community septic system to eliminate groundwater pollution. Stream protection requires conscientious planning by natural resource managers, developers, and local officials. Mitigation measures are mandatory to assist in the preservation of stream and riparian resources from the adverse effects of suburban development. (See also W90-05491) (Author's abstract) W90-05497

INTEGRATED RIPARIAN PLANNING IN THE URBAN SETTING.

TGS Technology, Inc., Fort Collins, CO.

G. C. Horak.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 41-43. 7 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Open space, *Colorado, *Riparian waters, *Recreation demand, *Riparian land, *Riparian rights, Legal aspects, Environmental protection, Environmental policy, Urban planning, Management planning, Stream improvement.

The city of Fort Collins, Colorado has implemented an innovative approach to riparian area creation and preservation. In 1974, the Fort Collins City Council approved the Open Space Plan that is an element in the Comprehensive Plan of the City. In April 1973, a 1% sales tax increase was approved by the voters for capital improvements, including money for open space land acquisition and acquisition of additional parks. Because of development pressure, the plan also recommended the dedication of a right-of-way for a non-motorized trail system. It was recommended that areas of unique vegetation and wildlife habitat be acquired. The plan also noted that floodplains should be maintained as open space. The solid foundation provided by farsighted plans (open space, basin master, urban fishery, wildlife, and national recreation area plans) are contributing elements to sensitive and sensible decisions concerning riparian areas. The citizens of Fort Collins, through these specific plans and actions, have been successfully protecting riparian areas. Thus, lands and waters are being preserved that are beneficial to fish and wildlife and provide the citizens of Fort Collins with functional values such as flood protection and recreational benefits. (See also W90-05491) (Mertz-PTT) W90-05498

INTERRELATIONSHIP BETWEEN WATERSHED CONDITION AND HEALTH OF RIPARIAN AREAS IN SOUTHWESTERN UNITED STATES.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ.

For primary bibliographic entry see Field 4D. W90-05499

NUTRIENT CYCLING AT THE LAND-WATER INTERFACE: THE IMPORTANCE OF THE RIPARIAN ZONE.

Oregon State Univ., Corvallis. Dept. of Rangeland Resources.

D. M. Green, and J. B. Kauffman.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 61-68. 2 fig, 3 tab, 80 ref.

Descriptors: *Watershed management, *Cycling nutrients, *Land management, *Water resources management, *Water law, *Riparian land, *Riparian waters, *Water chemistry, Poa, Kentucky bluegrass, Sedges, Carex, Mannagrass, Anaerobic conditions, Aerobic conditions, Oxidation-reduction potential, Phosphorus, Denitrification, Ecosystems, Ecology.

Riparian ecosystems are sites of important biogeochemical processes that affect the composition and structure of the streamside biota, as well as aquatic systems. Microbial activity, coupled with the slow diffusion of oxygen in waterlogged riparian soils, causes anaerobic conditions and reduction in reduction-oxidation (redox) potential. Redox potentials provide a useful measurement as to the intensity of anaerobic conditions and the degree of chemical transformation in riparian zones. Under anaerobic conditions, biogeochemical cycles differ greatly from the aerobic conditions of surrounding uplands. Different plant species are adapted to survive in varying levels of reduced waterlogged conditions such that different plant communities

Watershed Protection—Group 4D

occupy sites of different redox potential. For example, Kentucky bluegrass *Poa pratensis*-timothy *Phleum pratense* communities occurred in areas of high redox potential (well drained soils)(570 mV), beaked sedge *Carex rostrata* in moderate redox potential (-48 mV), and tall manna grass *Glyceria grandis* (-164 mV) in waterlogged, anaerobic soils. Recent research has shown that low redox potentials result in denitrification and that phosphorus immobilization processes occur within intact riparian ecosystems, thereby greatly influencing water quality. The effects of grazing or other anthropogenic disturbances can alter these biogeochemical cycles resulting in drastic alterations in riparian vegetation composition and productivity, aquatic ecosystems, and water quality. Given these important linkages to resource productivity, the effect of land use activities on biogeochemical cycles of riparian/stream ecosystems should be considered. (See also W90-05491) (Author's abstract) W90-05501

MANAGEMENT IMPLICATIONS FOR RIPARIAN DOMINANCE TYPES OF MONTANA. Montana Univ., Missoula. School of Forestry. For primary bibliographic entry see Field 6B. W90-05504

EFFECTS OF VEGETATION AND LAND USE ON CHANNEL MORPHOLOGY. Wisconsin Univ.-Madison. Dept. of Geography. C. Clifton. IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 121-129. 7 fig, 6 tab, 23 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Riparian land, *Channel morphology, *Riparian waters, *Grazing, *Streams, Forest watersheds, Mountain streams, Vegetation regrowth, Stream profiles, Temporal variability, Spatial variability, Environmental protection.

Spatial and temporal morphologic variability in mountain streams may be attributed to local prevailing conditions. Morphologically distinct reaches of Wickiup Creek, in the Blue Mountains of central Oregon, result from differences in the composition and structure of streamside vegetation, physiography, and land use. Comparisons of grazed and ungrazed meadow reaches and a forested reach loaded with large organic debris reveal specific differences related to the local environmental setting. Overall, width, depth, and cross section area do not increase systematically downstream. The greatest widths are found in the forested reach. Stream depths are at a maximum through the ungrazed meadow reach. Spatial variability results from prevailing vegetation conditions. Temporal variability in the ungrazed enclosure results from the exclusion of livestock and subsequent revegetation of the meadow. Over a 50-year period without grazing, a 94% reduction in channel cross section area occurred. (See also W90-05491) (Author's abstract) W90-05509

ECOLOGY OF TAMPA BAY, FLORIDA: AN ESTUARINE PROFILE. Mangrove Systems, Inc., Tampa, FL. For primary bibliographic entry see Field 2L. W90-05617

4D. Watershed Protection

SLOPE AND PHOSPHOGYPSUM'S EFFECTS ON RUNOFF AND EROSION. Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center. For primary bibliographic entry see Field 2J. W90-04626

DESIGN OF ROADSIDE CHANNELS WITH FLEXIBLE LININGS. Simons, Li and Associates, Inc., Fort Collins, CO.

Y. H. Chen, and G. K. Cotton. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-122584. Price codes: A06 in paper copy, A01 in microfiche. Hydraulic Engineering Circular No. 15, April 1988. 112p, 32 fig, 6 tab, 25 charts, 23 ref, 4 append.

Descriptors: *Erosion control, *Ditches, *Road construction, *Linings, *Bank stabilization, Vegetation, Gravel, Riprap, Stabilization.

Flexible linings provide a means of stabilizing roadside channels. Flexible linings are able to conform to changes in channel shape while maintaining the overall lining integrity. Permanent flexible lining such as riprap, gravel, or vegetation reinforced with synthetic mat are suitable for hydraulic conditions similar to those requiring rigid linings. Vegetation or temporary linings are suited to hydraulic condition where uniform flow exists and shear stresses are moderate. Design procedures are given for rock riprap, wire-enforced riprap, gravel riprap, woven paper net, jute net, fiberglass roving, curled wood mat, synthetic mat, and straw with net. Special design procedures are presented for composite channels and channels with steep gradients. The design procedures are based on the concept of maximum permissible tractive force. Methods for determination of hydraulic resistance and permissible shear stress for individual linings are presented. Nomographs are provided for solution of uniform flow conditions in trapezoidal channels. Nomographs are also provided for determination of resistance characteristics for vegetation and permissible shear stress for soils. (Author's abstract) W90-05130

MINERALOGY AND GRAIN SIZE OF SURFICIAL SEDIMENT FROM THE LITTLE LOST RIVER AND BIRCH CREEK DRAINAGES, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO. Geological Survey, Idaho Falls, ID. Water Resources Div. For primary bibliographic entry see Field 2J. W90-05273

NEW REVETMENT DESIGN CONTROLS STREAMBANK EROSION. Forest Service, Albuquerque, NM. Southwestern Region. R. A. Lafayette, and D. W. Pawelek. Public Works PUWOAH, Vol. 120, No. 13, p 54-57, December 1989. 2 fig, 6 ref.

Descriptors: *Riprap, *Bank stabilization, *Bank erosion, *Stream banks, *Erosion control, Bank protection, Stream erosion, Channel degradation, Fences, Fluvial sediments, Construction materials, New Mexico.

A watershed condition analysis of the Bluewater Creek watershed near Grants, NM, showed that stream channel meander cutting continued to provide excessive sediments to the fluvial system. The problem sites were located along the main channel of Bluewater Creek, one of two major streams contributing most of the flow into Bluewater Lake, a 2,350 acre impoundment in northwestern NM. A long-term program to improve hydrologic function and resultant benefits included controlling excessive streambank erosion. Channel degradation and stream meandering had left several actively eroding streambanks along the main Bluewater Creek channel. Various streambank erosion control measures were evaluated for their advantages and disadvantages, including livestock control, riparian planting, bank shaping, gabions, Kellner jacks or tetrapods, and porous fence revetment. The latter method was chosen, partly since it allows water to pass through the system, and encourages plant growth. The fence design chosen uses pre-drilled galvanized steel U-channel sign posts, with fence material of 12.5 gauge galvanized V-mesh woven wire. The revetment consists of two elements: one or more main segments aligned parallel to flow, and a series of baffles oriented perpendicular to flow, extending from the main segments back into the stream bank. All disturbed soil was seeded to promote groundcover and reduce erosion.

Local willow cuttings and cottonwood poles were planted, and livestock grazing was eliminated for at least five years. The revetments were installed at two sites in late fall 1986. The project has survived both high spring runoff and summer runoff events. Bank erosion is reduced, sediment deposition is occurring as planned, and plant growth is excellent. (VerNooy-PTT) W90-05331

NEW METHOD OF STREAM BANK PROTECTION. Saint Charles City Engineer's Office, MO.

C. Baber. Public Works PUWOAH, Vol. 120, No. 13, p 46, December 1989.

Descriptors: *Retaining walls, *Bank protection, *Bank stabilization, *Stream banks, *Erosion control, Bank erosion, Construction methods, Construction costs.

With five creeks flowing through its residential and commercial developments, the property owners in St. Charles, MO are all too familiar with creek bank erosion. Over the years a variety of methods have been employed by the city and private owners in an attempt to curb this erosion. Serious bank erosion at Cole Creek resulted in the city investigating various erosion control methods, including grid confinement, an interlocking sheet-piling wall, concrete retaining wall, and gabion basket wall. A new method of creek bank stabilization was introduced to the city in late 1987 and subsequently used at the Cole Creek site. The Waterloft method, is a variation of the Loffelstein wall system that originated in Europe. This retaining wall system consists of trough shaped concrete modules or units (18 in. x 26 in. and 176 pounds) with interlocking wings. The configuration of the modules will allow vegetation to grow along the wall eventually, blending the wall into its natural surroundings. The completed Waterloft wall is 85 ft long and 20 ft high, and cost about \$56,000 to construct. This represents a 34% savings over the gabion basket wall, the next least expensive option considered. (VerNooy-PTT) W90-05332

FILL SLOPE REPAIR USING SOIL BIOENGINEERING SYSTEMS. Sotir (Robbin B.) and Associates, Marietta, GA. For primary bibliographic entry see Field 8D. W90-05333

EMERGENCY WATERSHED PROTECTION USING STRAW BALES. Miles (Thomas R.), Portland, OR. T. R. Miles, J. Burt, K. Hale, and J. Lofton. Public Works PUWOAH, Vol. 120, No. 13, p 32-35, December 1989. 2 tab, 4 ref.

Descriptors: *Check dams, *Reservoir silting, *Straw, *Soil erosion, *Sediment control, *Watershed management, Silting, Reservoir operation, Erosion control, Planting management, Seeds, Organizations, Construction methods, Oregon.

An emergency watershed protection project was carried out in a municipal watershed in western Oregon after forest fires caused extreme damage to Dallas, Oregon's sole water supply. Public and private entities cooperated to seed damaged areas and build temporary dams to protect the reservoir from siltation during winter storms. This article describes the results of project organization and coordination using coordinated resource management planning, aerial seeding on forest soils, and the construction and maintenance of temporary dams using large straw bales, transported by helicopter. The 1987 fire left 3,000 acres bare and 2,000 acres partially burned. Most upper slopes were bare, and the watershed has long slopes ranging from 30% to over 75%. While the fire was still burning, the Soil and Water Conservation District convened a coordinated resource management planning meeting to consider the erosion problem. All work was completed less than 6 weeks after the fire began and consisted of grass seeding, tree

Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

Group 4D—Watershed Protection

planting, and construction of a rock sediment retention dam and straw bale sediment dams at 19 sites. The large straw bales were stable, especially where they became saturated with silt. Sites, construction and maintenance of the 19 straw dams are detailed. After the first year there was significant grass cover, sediment structures were full, sediment in the reservoir was minimal and the city reported few problems with fine sediment downstream. Participating engineers highly recommend the straw dam technique for sediment control and non-point source pollution control. (VerNooy-PTT)
W90-05334

INTERRELATIONSHIP BETWEEN WATERSHED CONDITION AND HEALTH OF RIPARIAN AREAS IN SOUTHWESTERN UNITED STATES.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ.
L. F. Debano, and L. J. Schmidt.
IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 45-52. 2 tab, 51 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Watershed management, *Riparian land, *Riparian waters, *Environmental protection, *Watersheds, Streams, Stream erosion, Livestock, Streamflow, Stream degradation, Grazing, Management planning.

Sensitive hydrologic interrelationships exist between watershed condition and the health of associated riparian areas in the southwestern USA. The impact of extensive unmanaged livestock grazing, wildfires, and past forest clearing, coupled with numerous small linear perturbations such as travelways, low standard roads, and livestock trails, has dramatically illustrated the interrelationship between watershed condition and riparian health. Vegetation removal and soil compaction substantially increased surface runoff, produced sediment-laden flows, and increased erosive power to the channel system, upsetting the balance between riparian areas and the surrounding watershed. This led to the degradation, or in some cases complete destruction, of many riparian areas. A key factor in improving deteriorated riparian areas is understanding the balance that existed between watershed condition and riparian health in near pristine conditions. Under such conditions, watershed slopes and riparian channels were able to dissipate rainfall and concentrate flow energies produced during different precipitation events. The interdependency between hydrologic processes operating on upland slopes of a watershed and the channel processes affecting downstream riparian stability in the southwestern USA are discussed. The most obvious practices benefiting riparian communities are upstream treatments aimed at improving watershed condition, lengthening duration of streamflow, and stabilizing channels to reduce erosion. Improving watershed condition involves improved livestock management, which is sometimes supplemented by cultural treatments, to gain better livestock distribution and control. In addition, strategically applied mechanical stabilization of channels may become a necessary part of restoration treatment when significant gullying and erosion has occurred in upland tributaries. (See also W90-05491) (Mertz-PTT)
W90-05499

MANAGEMENT OF WINTER SOIL TEMPERATURES TO CONTROL STREAMBANK EROSION.

Nevada Univ., Reno. Dept. of Range, Wildlife and Forestry.
C. Bohn.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 69-71. 2 tab, 20 ref.

Descriptors: *Land management, *Water resources management, *Water laws, *Soil water, *Freeze-thaw tests, *Soil-water-plant relationships, *Freezing, *Riparian land, *Stream banks, *Temperature

effects, Stream degradation, Nevada, Grass, Soil stabilization, Soil temperature.

Winter soil temperatures were measured in streambanks under different vegetation cover conditions in northeastern Nevada. Grass provided significant streambank insulation at two different elevations and aspects when compared to bare soils. Grass cover moderated average maximum and minimum soil temperatures, reduced average daily soil temperature fluctuations, and decreased the number of days that the soil temperature fell below 0 C. Previous research on horizontal soil surfaces has shown that frost-heaving and freeze-thaw cycles alter soil strength. Therefore, it is postulated that the formation of soil ice weakens the internal structure of streambanks. Weakened banks are less able to resist disturbance from high velocity runoff flows and ice floes and overburden pressure exerted on the weight-bearing strata. The temperature modifications resulting from vegetative cover appear to be sufficient to reduce the number of freeze-thaw cycles along the streambank face. Riparian management should be designed to provide sufficient vegetative cover over the winter to insulate streambanks and maintain soil strength. (See also W90-05491) (Author's abstract)
W90-05502

CHARACTERISTICS OF RIPARIAN PLANT COMMUNITIES AND STREAMBANKS WITH RESPECT TO GRAZING IN NORTHEASTERN UTAH.

Intermountain Forest and Range Experiment Station, Boise, ID.
W. S. Platts, and R. L. Nelson.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 73-81. 5 fig, 4 tab, 29 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Channel morphology, *Riparian land, *Riparian waters, *Grazing, *Stream banks, *Utah, *Vegetation effects, Vegetation establishment, Carex, Sedges, Poa, Stream improvement, Environmental protection, Environmental effects.

Streambanks and associated riparian vegetation were studied in grazed and ungrazed pastures along Big Creek, Rich County, Utah, to determine whether differences in streamside community type composition and condition were related to differences in streambank morphology. Considerable structural difference was observed between grazed sites and sites where grazing has been suspended or greatly reduced for nearly two decades. In the ungrazed sites, structures that had been installed to improve fish habitat had apparently raised water tables and thus were associated with changes in riparian vegetation. Similar trends seem to be starting in unimproved sites that have been protected from grazing for only 4 years. Streambank morphology varied widely among the various community types. Certain riparian community types (e.g., those characterized by Carex spp.) were able to maintain bank structure under grazing use, but others (e.g., those characterized by Poa pratensis) appeared to be highly unstable when grazed. Higher order classification revealed groups of streamside community types that, in the absence of grazing, could be expected to confer similar streambank characteristics. An apparently distinct, successional sequence from sandbar-dominated communities through Juncus balticus-dominated communities to Poa pratensis-dominated communities or sedge-dominated communities was evident. Where sedges can become dominant, they clearly create the most optimal streambank structure. Even under grazed conditions, some of the optimum bank characteristics were associated with this community type. Moderate grazing pressure after viable sedge communities have become reestablished may be acceptable, but the managers responsible must ensure that Carex spp. community types do not revert to less favorable communities like Poa pratensis. (See also W90-05491) (Author's abstract)
W90-05503

FOREST PRACTICES AND RIPARIAN MANAGEMENT IN WASHINGTON STATE: DATA BASED REGULATION DEVELOPMENT.
Weyerhaeuser Co., Centralia, WA. Western Forestry Research Center.
For primary bibliographic entry see Field 6E.
W90-05505

COMPATIBILITY OF LIVESTOCK GRAZING STRATEGIES WITH FISHERIES.

Intermountain Forest and Range Experiment Station, Boise, ID. Forestry Sciences Lab.
W. S. Platts.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 103-110. 2 tab, 16 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Grazing, *Livestock, *Riparian land, *Riparian waters, *Riparian vegetation, *Range management, *Environmental protection, *Watershed management, *Stream fisheries, Management planning, Erosion, Stream degradation.

Livestock grazing strategies and techniques have been developed for upland ranges to increase plant and litter cover, encourage growth of favorable plant species, improve plant species composition, increase plant vigor, and protect soil from erosion. These same objectives must be met when using the riparian area for livestock grazing. Grazing strategies were preliminarily evaluated with respect to their compatibility with the requirements of the stream-riparian zone and productive fisheries. The most promising grazing strategies for maintaining or rehabilitating riparian-stream systems are those that include one or more of the following options: (1) including a riparian pasture within a grazing allotment or operation to allow riverine-riparian ecosystem to be managed separately from the uplands; (2) fencing streamside corridors to allow stream-riparian habitats to recover; (3) changing the kind of livestock for better grazing compatibility with rangeland types; (4) increasing non-grazing time in the grazing cycle; (5) reducing streamside forage use intensity; (6) controlling the timing of forage use so grazing occurs during periods most compatible with riverine riparian ecosystems; (7) managing grazing programs as specified and required in properly prepared allotment management plans. A better understanding of management strategies with respect to their stream-riparian compatibility should help fishery specialists work more closely and effectively with range conservationists in rangeland management. (See also W90-05491) (Mertz-PTT)
W90-05506

RESPONSE OF A SOUTHWEST MONTANA RIPARIAN SYSTEM TO FOUR GRAZING MANAGEMENT ALTERNATIVES.

Montana State Univ., Bozeman. Dept. of Animal and Range Sciences.

C. B. Marlow, K. Olson-Rutz, and J. Atchley.
IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 111-116. 3 fig, 5 tab, 15 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Grazing, *Range management, *Montana, *Riparian land, *Riparian waters, *Stream fisheries, *Trout, *Riparian vegetation, Stream stabilization, Environmental protection, Management planning, Stream banks, Livestock.

The effects of deferred rotation, time control (Savory Grazing Method), season-long, and livestock exclusion on streambank stability and trout habitat condition in a southwestern Montana riparian zone has been monitored since 1986. Although livestock exclusion appeared to improve channel conditions in 1986, there was no significant difference among any of the treatments thereafter. The decline in trout habitat condition appeared to be more a function of stream discharge and channel aggradation than grazing management. The lack of

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significant differences in bank stability among the various treatments during three consecutive drought years suggests that it is the interaction between grazing and stream discharge events that dictate the magnitude of streambank alteration. Downward shifts in livestock numbers will probably not limit streambank degradation and loss of trout habitat. Decreasing the length of time cattle have access to a stream reach and adjusting the grazing period to coincide with low stream bank moisture levels shows promise for the improvement of riparian zone condition. (See also W90-05491) (Author's abstract)
W90-05507

GRAZING AND RIPARIAN MANAGEMENT IN SOUTHWESTERN MONTANA.

Bureau of Land Management, Dillon, MT.
L. H. Myers.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 117-120. 3 tab, 9 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Grazing, *Range management, *Riparian land, *Montana, *Riparian vegetation, *Vegetation regrowth, *Environmental protection, *Plant populations, *Management planning, *Livestock.

A subjective analysis of riparian vegetation response in 34 grazing systems was completed in the Dillon Resource Area in southwestern Montana. Evaluations were made on allotments that had grazing management systems of 10 to 20 years duration. Class of livestock was cow-calf pairs or yearling cattle. Most traditional grazing systems developed for uplands did not accommodate riparian recovery. Grazing systems that do not improve riparian vegetation must be documented to avoid their future misapplication. The following are recommendations for the development of grazing systems where stream riparian maintenance or recovery is an objective: (1) provide for residual vegetative cover either through regrowth or rest treatments during at least 75% of the years, or annually if possible; (2) through on-site studies, determine how much time is required to provide adequate herbaceous regrowth to meet floodplain function needs and incorporate this into the grazing prescription; (3) reduce the duration of grazing treatment to the greatest extent practical; (4) design grazing treatments to take advantage of favorable seasonal livestock dispersal behavior; (5) incorporate sufficient growing season rest to provide for good vigor and regeneration in all riparian plants; (6) where deciduous woody species are important in the composition, limit the frequency of fall grazing treatments to about one year in four; and (7) insist upon strict grazing system compliance. (See also W90-05491) (Mertz-PTT)
W90-05508

STREAMSIDE ZONES AND WILDLIFE IN SOUTHERN U.S. FORESTS.

Southern Forest Experiment Station, Nacogdoches, TX. Wildlife Habitat Lab.
For primary bibliographic entry see Field 4A.
W90-05510

REHABILITATING DEPLETED RIPARIAN AREAS USING CHANNEL STRUCTURES.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ.
L. F. DeBano, and W. R. Hansen.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 141-148. 5 fig, 23 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Riparian vegetation, *Sediment control, *Riparian land, *Watershed management, *Environmental protection, *Colorado, *New Mexico, *Stream improvement, *Stream stabilization, *Streamflow, *Streams, *Stream degradation, *Rehabilitation.

Abusive land use activities have deteriorated valuable riparian areas in the southwestern USA. Loss

of protective cover causes erosion that reduces soil moisture and channel stability that is necessary for maintaining riparian areas. Review of three rehabilitation projects (the Alkali Creek watershed in the White River National Forest near Silt, Colorado, the Silver City watershed north of Silver City, New Mexico, and the High Clark Draw project in the upper San Francisco River watershed in New Mexico's Apache National Forest) indicate that channel structures store sediment, stabilize channels, raise water tables, and enhance riparian vegetation. Saturated flows enhance soil moisture and aid in the maintenance and establishment of riparian vegetation. Rehabilitation planning should establish quantifiable treatment objectives and consider the need for riparian planting, continued watershed management, structural maintenance, and the effect of channel structures on channel dynamics. (See also W90-05491) (Mertz-PTT)
W90-05512

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

RISK ASSESSMENT OF GROUNDWATER CONTAMINATION AND CURRENT APPLICATIONS IN THE DECISION-MAKING PROCESS.

United Technologies Corp., East Hartford, CT.
F. W. Johnson.
Journal of Environmental Systems JEVSBH, Vol. 18, No. 4, p 279-297, 1988/89.

Descriptors: *Risk assessment, *Pollutant identification, *Groundwater pollution, *Legal aspects, *Liability, *Remedies, *Cost allocation, *Costs, *Case studies, *Cleanup operations, *Groundwater.

The information needs for risk assessments of groundwater contamination were assessed in light of attendant liability, regulatory, and economic concerns. Specific reasons for conducting risk assessments include (1) lender or investor requirements, (2) state laws requiring risk assessments and subsequent disclosures at the time of any property transfer, (3) insurance requirements, (4) corporate loss control programs, and (5) regulatory enforcement requirements. Case studies of environmental remediation alternatives, potential facility liability, and environmental risks are presented for a former tobacco farm turned residential, a small commercial furniture store, an automotive tubing manufacturer, and a steel bar processing plant. Experience with hundreds of risk assessments has shown that nearly every site is unique, and that overly standardized approaches to the assessment are difficult to apply. Therefore, creativity and experience combined with good technical knowledge of groundwater assessment techniques provide the optimal combination for conducting an effective risk management. (Friedmann-PTT)
W90-04606

IRON AND TRACE METALS IN SOME TIDAL MARSH SOILS OF THE CHESAPEAKE BAY.

Maryland Univ., College Park. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-04617

PHOSPHORUS-31 MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE OF WASTEWATER SLUDGES AND SLUDGE-AMENDED SOIL.

Florida Univ., Gainesville. Dept. of Soil Science.
Z. R. Hinedi, A. C. Chang, and J. P. Yesinowski.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1053-1056, July/August 1989. 6 fig, 30 ref.

Descriptors: *Sludge analysis, *Phosphorus, *Pollutant identification, *Soil amendments, *Nuclear magnetic resonance, *Loam, *Soil horizons, *Digestion, *Sludge.

Phosphorus-31 magic angle spinning nuclear magnetic resonance (MAS NMR) spectroscopy was used to examine the forms of P in two municipal sludges and a sludge-amended soil. The signal-to-noise ratio and the resolution of the spectra improved considerably when paramagnetics in the sludge and sludge-treated soil samples were removed by a reducing treatment involving citrate-bicarbonate-dithionite (CBD). The spectra suggested that the P solid phases in the anaerobically digested sludge from Los Angeles County, California, were calcium phosphates. The strong paramagnetic effects, however, precluded more precise identification of the calcium phosphate phase. In the anaerobically digested alum-treated sludge from Riverside, three P solid phases were detected, carbonated apatite, a pyrophosphate, and aluminum phosphate. In the Domino soil (fine-loamy, mixed, thermic Xerollic Calciorthid), amended with sludge from Los Angeles County, P31 MAS NMR indicated the presence of carbonated apatite and pyrophosphate solid phases. (See also W90-04620) (Author's abstract)
W90-04619

MEMBRANE FILTRATION DIFFERENTIATION OF E. COLI FROM COLIFORMS IN THE EXAMINATION OF WATER.

Public Health Lab., Haifa (Israel).

A. Mates, and M. Shaffer.

Journal of Applied Bacteriology JABAAA, Vol. 67, No. 4, p 343-346, 1989. 3 tab, 19 ref.

Descriptors: *Pollutant identification, *Bioindicators, *Membrane filters, *Drinking water, *Bacterial analysis, *Escherichia coli, *Coliforms.

A membrane filter-Endo agar method for enumerating *Escherichia coli* as distinct from other coliforms in drinking water was developed. It was tested on samples collected from untreated surface water and piped drinking water supplies in northern Israel. Membranes containing coliform colonies are transferred to nutrient agar containing 4-methyl umbelliferyl-beta-D-glucuronide (MUG) and incubated at 35 C for 4 h. The MUG is hydrolyzed by the glucuronidase of *E. coli* and the fluorogenic product is visualized. The method recovered 98% of *E. coli* without false positives and is proposed as an additional test in routine water examination for the detection of pollution. (Author's abstract)
W90-04646

SEDIMENT TOXICITY ASSESSMENT USING BACTERIAL BIOLUMINESCENCE: EFFECT OF AN UNUSUAL PHYTOPLANKTON BLOOM.

Institut Rudjer Boskovic, Rovinj (Yugoslavia).
Centar za Istrazivanje Mora.

For primary bibliographic entry see Field 7B.
W90-04655

SURVEY OF BARIUM IN ITALIAN DRINKING WATER SUPPLIES.

Florence Univ. (Italy). Inst. of Hygiene.
E. Lanciotti, N. Comodo, L. Gambassini, E. Berba, and G. Vallone.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 833-837, December 1989. 1 fig, 1 tab, 11 ref.

Descriptors: *Italy, *Barium, *Trace metals, *Drinking water, *Pollutant identification, *Groundwater pollution, *Water pollution effects, *Public health.

Barium levels were measured in Tuscany drinking water supplies, represented by 60 brands of bottled water, 92 groundwater samples, and 39 municipal treated waters. The water samples were collected in the daytime from January 1987 to April 1988 using polyethylene bottles. Barium was determined using graphite furnace atomic absorption spectrometry. A great variability was present in the barium levels in bottled waters (range 7-660 micrograms/liter) and groundwaters (range 7-1160 micrograms/liter) while the barium concentrations in treated waters were more homogeneous (range 13-

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140 micrograms/liter). The median value for groundwater was higher than the maximum allowable concentration according to the EEC guidelines. (Geiger-PTT)
W90-04676

CLAM BURROWING BIOASSAY FOR ESTUARINE SEDIMENT.
District of Columbia Univ., Washington. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-04677

WATER HYACINTH AS INDICATOR OF HEAVY METAL POLLUTION IN THE TROPICS.
Institute of Transport Investigations, Havana (Cuba).
H. Gonzalez, M. Lodenius, and M. Otero.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 910-914, December 1989. 2 fig, 3 tab, 9 ref.

Descriptors: *Water hyacinth, *Heavy metals, *Path of pollutants, *Cuba, *Aquatic plants, *Bioindicators, *Bioaccumulation, Pollutant identification, Water pollution sources, Copper, Zinc, Iron, Manganese, Lead, Chromium, Cobalt.

Roots of water hyacinths (*Eichhornia crassipes*) were collected from the river Sagua la Grande, central Cuba, six times during the years 1985 to 1988. The roots were dried, digested in concentrated HNO₃/HClO₄, and their contents of heavy metals (Cu, Zn, Fe, Mn, Pb, Cr, and Co) were determined by flame atomic absorption spectrometry. The lowest concentrations of metals were found in water hyacinths taken upstream from the city of Sagua, which are considered less polluted. Highest concentrations were found in the zone situated near Sagua city which receives urban and industrial effluents. In the river downstream from the city, levels of metal in hyacinth root were lower than within the city but still indicated the influence of pollution from the city. In general there were significant differences between the values above and within or below the city. This effect was true for Mn, Cu, and Zn but less so for Fe, suggesting that this metal would not serve as a good indicator of urban effluents. The samples collected from polluted and unpolluted areas show the ability of *Eichhornia crassipes* to accumulate heavy metals in the root and serve as a bioindicator of metal pollution. (Geiger-PTT)
W90-04684

HYDROXYATRAZINE AND ATRAZINE DETERMINATION IN SOIL AND WATER BY ENZYME-LINKED IMMUNOSORBENT ASSAY USING SPECIFIC MONOCLONAL ANTIBODIES.
CIBA-GEIGY A.G., Basel (Switzerland). Pharmaceuticals Research Labs.
J. M. Schlaeppli, W. Foery, and K. Ramsteiner.
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 37, No. 6, p 1532-1538, November 1989. 4 fig, 6 tab, 26 ref.

Descriptors: *Immunsorbent assay, *Atrazine, *Herbicides, *Soil contamination, *Pollutant identification, Enzymes, Antibodies, Triazine pesticides, Soil analysis, Water analysis, Assay.

Monoclonal antibodies (MAbs) were obtained against the herbicide atrazine and its metabolite hydroxyatrazine by immunizing mice with protein conjugates of both compounds. By using the ELISA kit, it was found that the anti-hydroxyatrazine MAbs cross-reacted predominantly with hydroxy-propazine. The anti-atrazine MAbs cross-reacted with propazine and, to a much lower extent, with a few other s-triazines and hydroxy-s-triazines. Atrazine could be detected in water samples with a sensitivity of 0.05 nanograms/milliliter. Average recoveries from soil samples fortified with atrazine or hydroxyatrazine, measured by ELISA, were comparable to those measured by GLC or HPLC. Soil samples of unknown atrazine and hydroxyatrazine content were analyzed by GLC, HPLC, and ELISA. Interference during

UV monitoring of hydroxyatrazine by HPLC analysis was observed. Despite limited specificity due to cross-reacting substances, the results demonstrate that the ELISA immunoassay represents a valuable method for detecting trace amounts of atrazine and hydroxyatrazine in the soil. (Author's abstract)
W90-04688

USE OF MIXED-FUNCTION OXYGENASES TO MONITOR CONTAMINANT EXPOSURE IN WILDLIFE.
Patuxent Wildlife Research Center, Laurel, MD.
B. A. Ratner, D. J. Hoffman, and C. M. Marn.
Environmental Toxicology and Chemistry ETXCDK, Vol. 8, No. 12, p 1093-1102, 1989. 1 tab, 62 ref.

Descriptors: *Enzymes, *Toxicology, *Monitoring, *Bioindicators, *Water pollution effects, *Wildlife, *Ecological effects, Amphibians, Birds, Reptiles, Mammals, Fish, Seasonal variation, Environmental effects.

The utility of mixed-function oxygenase (MFO) enzymes as a bioeffects monitor for wildlife (amphibians, reptiles, birds and mammals) in view of their widespread use as indicators of contaminant exposure in aquatic invertebrates and fish is reviewed. Phylogenetic trends in MFO activity, toxicological implications of induction and the relationship between contaminant exposure and MFO activity are discussed. Low MFO activity in seabirds and in the European sparrowhawk (*Accipiter nisus*) is attributed to the accumulation of organochlorine pesticides in these species. Substantial laboratory data demonstrates that MFO induction interferes with steroid metabolism in mallards (*Anas platyrhynchos*), quail (*Coturnix coturnix*) and ringdoves (*Streptopelia risoria*); however, there is no direct field evidence supporting this contention. Field studies using avian embryos and hatchlings suggest that MFO induction has utility for documenting contaminant exposure; however, findings in adult birds and mammals are equivocal. Age, sex and season are sources of variation that require consideration when undertaking field trials. Further understanding of MFO inducibility among species and application of recently developed analytical techniques including quantification of specific cytochrome P-450 isozymes are warranted. (Geiger-PTT)
W90-04689

CONCENTRATIONS OF CHLORINATED PESTICIDES AND PCBs IN MICROLAYER AND SEAWATER SAMPLES COLLECTED IN OPEN-OCEAN WATERS OFF THE U.S. EAST COAST AND IN THE GULF OF MEXICO.
Little (Arthur D.), Inc., Cambridge, MA. Marine Sciences Unit.
For primary bibliographic entry see Field 5B.
W90-04700

LIQUID CHROMATOGRAPHIC ANALYSIS OF CHLOROTRIAZINE HERBICIDES AND ITS DEGRADATION PRODUCTS IN WATER SAMPLES WITH PHOTODIODE ARRAY DETECTION: I. EVALUATION OF TWO LIQUID-LIQUID EXTRACTION METHODS.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
G. Durand, and D. Barcelo.
Toxicological and Environmental Chemistry TXECBP, Vol. 25, No. 1, p 1-11, 1989. 4 fig, 3 tab, 22 ref.

Descriptors: *Herbicides, *Triazine pesticides, *Pollutant identification, *Liquid chromatography, Separation techniques, Trace levels, Spectral analysis, Water analysis.

A liquid-liquid extraction method using dichloromethane:ethyl acetate (50:50) + 0.1 M ammonium formate has been developed for the trace analysis of chlorotriazine herbicides and their degradation products in the range of 100-0.1 ppb using spiked artificial seawater samples. Results showed good recovery rates with low standard deviations. The UV spectral information obtained

from the liquid chromatography with diode array detection has been demonstrated to be useful for the distinction of the chlorotriazines and their degradation products. (Geiger-PTT)
W90-04706

COMPARISON OF EXTRACTION METHODS FOR POLYCYCLIC AROMATIC HYDROCARBON DETERMINATION IN SEDIMENTS.
Brno Univ. (Czechoslovakia). Dept. of Environmental Studies.
I. Holoubek, J. Paasivirta, P. Maatela, M. Lahtipera, and I. Holoubkova.
Toxicological and Environmental Chemistry TXECBP, Vol. 25, No. 2-3, p 137-154, 1989. 7 fig, 9 tab, 20 ref.

Descriptors: *Aromatic compounds, *Polycyclic aromatic hydrocarbons, *Fluvial sediments, *Pollutant identification, *Lake sediments, *Separation techniques, Sample preparation, Ultrasonics, Comparison studies, Adsorption.

Different sample preparation methods for the determination of polycyclic aromatic hydrocarbons (PAHs) in lake and river sediments were compared and evaluated. Freeze-dried sediment materials were extracted using Soxhlet extraction, ultrasonic agitation and digestion with various solvents and solvent mixtures. Similarly, clean-up methods using various types of sorbents for separation of PAHs were tested. The following method gives the best results for the determination of PAHs: freeze-dried sediment samples were extracted using Soxhlet extractor with dichloromethane (6 hr, dark), extracts were cleaned up using Silica gel and a mixture of n-hexane-dichloromethane was used for the elution of PAHs. This method was used for the determination of 7 selected PAHs in sediment samples from Finnish lakes and Czech streams. (Author's abstract)
W90-04707

RAPID POLLUTION ASSESSMENT IN TIDAL WATERS.
Southern Water Authority, Chatham (England). Kent Div.
R. A. Dines, and J. R. Wharfe.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1903-1906, 1989. 3 fig, 4 ref.

Descriptors: *Pollutant identification, *Path of pollutants, *Estuaries, *Tidewater, Industrial wastes, Baseline studies, Outfall, Wastewater pollution, Sediments, Marine sediments, Water pollution effects, Coliforms, Pulp and paper industry, Oxidation-reduction potential, Particle size, Organic carbon.

A package of investigational techniques was developed to assess pollution in marine and estuarine sediments. It can be used at different levels, from a rapid contour mapping of organic decomposition in the sediments to detailed impact assessment including effects on mud-dwelling organisms. The methods include redox potential measurement, organic carbon analysis, the variable factor (pollutant specific to the area, e.g., coliform or paper mill wastes), population structure of mud-dwelling organisms, and particle size analysis. The assessment technique was applied to a region near a paper mill and as part of a baseline study at the site where a sewage outfall is scheduled to begin discharging partially treated sewage. The assessment showed that even where sediment and surface water quality are acceptable (at the edge of the area affected by the paper mill waste), blanketing by paper solids has eliminated many of the sensitive species. (Cassar-PTT)
W90-04800

MEMBRANE FILTER PROCEDURE FOR ENUMERATION OF PSEUDOMONAS AERUGINOSA IN WATER.
Universitat Politècnica de Valencia (Spain). Dept. of Hydraulic and Environmental Engineering.
J. L. Alonso, E. Garay, and E. Hernandez.
Water Research WATRAG, Vol. 23, No. 12, p 1499-1502, December 1989. 3 fig, 1 tab, 21 ref.

WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

Identification Of Pollutants—Group 5A

Descriptors: *Pseudomonas, *Pathogenic bacteria, *Bacterial analysis, *Membrane filters, Human diseases, Isolation, Culturing techniques, Water pollution.

A variety of recovery methods has been developed in attempts to enumerate *P. aeruginosa*, a human pathogen and ubiquitous bacterial contaminant of surface waters and soils, from environmental sources by most probable number (MPN) and membrane filter (MF) techniques. In this report, the efficiency of replacing the antibiotics in mPA-C agar by C-390 (9-chloro-9-(4-diethylamino-phenyl)-10-phenylacridan) as selective agent, has been studied, and the new medium, mPA-C390 has been compared with mPA-C and with the MPN procedure for the recovery of *P. aeruginosa* from different kinds of fresh water. In a second step, a resuscitation technique to recover stressed *Pseudomonas aeruginosa* cells was tested with the above MF media. Counts obtained with the MPN technique were always significantly higher than when using MF without resuscitation. No significant differences were obtained between the MPN and MF techniques when the resuscitation step was used with the MF technique. The media mPA-C390 and mPA-D390 present the advantage of being autoclavable and specific for selective isolation of *P. aeruginosa* from different kinds of waters. (Author's abstract) W90-04837

ORGANIC ISOLATION FROM FRESH AND DRINKING WATERS BY MACROPOROUS ANION-EXCHANGE RESINS.
Politechnika Warszawska (Poland). Faculty of Sanitary and Hydraulic Engineering. J. Naumczyk, L. Szpyrkowicz, and F. Zilio Grandi.

Water Research WATRAG, Vol. 23, No. 12, p 1593-1597, December 1989. 2 fig, 2 tab, 20 ref.

Descriptors: *Water analysis, *Water treatment, *Drinking water, *Natural waters, *Separation techniques, *Anion exchange, *Resins, *Chemical analysis, Humic acids, Pollutant identification, Organic compounds, Water pollution.

Knowing the composition of organic impurities in water resources is a factor of great importance in defining their possible use. Identification of organic compounds in water is facilitated by their isolation and transfer into organic solvent. Research on the isolation of organic pollutants from water is presented. Five anionic macroporous resins (AMPR) (Varion AT400, strongly basic Asmite 229N, Zerolite 553N, Wofatite EA60, and weakly basic Amberlite IR93) were used for humic substances and other anionic organics isolation. Varion AT400 was the best anionic resin, producing about 90% recovery of humic substances and a lower recovery for other anionic substances. NaCl is generally the most effective component in the solutions used for the organic desorption from AMPR. NaOH added to NaCl solution improves the desorption effects. Nearly complete desorption was achieved by NaCl/NaOH 10%/2% solution, at a volume of about 3.5 times the resin bed volume. Reducing the NaCl concentration from 10 to 5% gave a smaller desorption decrease effect in comparison with other resins. (Author's abstract) W90-04848

IC: A POWERFUL ANALYTICAL TECHNIQUE FOR ENVIRONMENTAL LABORATORIES.
Dionex Corp., Sunnyvale, CA.
For primary bibliographic entry see Field 7B. W90-04850

USE OF SEGMENTED MICROCONTINUOUS FLOW ANALYSIS AND FIA IN WATER ANALYSIS.
ALPKEM Corp., Clackamas, OR.
For primary bibliographic entry see Field 7B. W90-04851

PHYTOPLANKTON DIVERSITY INDICES AS EUTROPHICATION INDICATORS OF THE ROMANIAN INSHORE WATERS.

Institutul Roman de Cercetari Marine, Constanta (Romania).
For primary bibliographic entry see Field 5C. W90-04857

COMPARISON OF CHEMICAL ANALYSES OF BOAT AND HELICOPTER-COLLECTED WATER SAMPLES.
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV. Acid Deposition Dept.
For primary bibliographic entry see Field 7B. W90-04894

WATER QUALITY INDEX FOR RIVER MANAGEMENT.
For primary bibliographic entry see Field 5G. W90-04904

REFINEMENTS TO THE BOD TEST.
For primary bibliographic entry see Field 7B. W90-04908

COMPARISON OF MEMBRANE FILTRATION AND AUTOANALYSIS COLILERT PRESENCE-ABSENCE TECHNIQUES FOR ANALYSIS OF TOTAL COLIFORMS AND ESCHERICHIA COLI IN DRINKING WATER SAMPLES.
Glenmore Waterworks Lab., Calgary (Alberta). C. M. Lewis, and J. L. Mak.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3091-3094, December 1989. 2 tab, 10 ref.

Descriptors: *Coliforms, *Bacterial analysis, *Escherichia coli, *Drinking water, *Autoanalyzers, *Membrane filters, Testing procedures, Pathogens, Water analysis, Comparison studies.

Over a 4-month period, 950 samples of treated drinking water were analyzed for total coliforms and *Escherichia coli* by both membrane filtration and Autoanalysis Colilert presence-absence techniques. The two tests agreed 97% of the time on the basis of presumptive total coliform results and 98.5% of the time on the basis of verified total coliform results. Samples which produced disagreement between the two tests were most often total coliform positive by membrane filtration and total coliform negative by Autoanalysis Colilert presence-absence. *E. coli* was recovered four times: twice by membrane filtration only, and twice by Autoanalysis Colilert presence-absence only but without the diagnostic fluorescence reaction. In two samples, *E. coli* could not be isolated from fluorescence-positive Autoanalysis Colilert presence absence tests. On the basis of these results, the Autoanalysis Colilert presence absence test was implemented as the routine analytical procedure for total coliforms, but not for *E. coli*. (Author's abstract) W90-04933

EVALUATION OF IMMUNOFLOURESCENCE TECHNIQUES FOR DETECTION OF CRYPTOSPORIDIUM OOCYSTS AND GIARDIA CYSTS FROM ENVIRONMENTAL SAMPLES.
Arizona Univ., Tucson. Dept. of Nutrition and Food Science.
J. B. Rose, L. K. Landeen, K. R. Riley, and C. P. Gerba.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3189-3196, December 1989. 3 fig, 10 tab, 22 ref.

Descriptors: *Cryptosporidium, *Giardia, *Protozoa, *Pathogens, *Water analysis, Antibody tests, Monoclonal antibodies, Membrane filters, Testing procedures, Formaldehyde, Bleach, Potassium dichromate, Oocysts, Cysts.

Cryptosporidium and Giardia species are enteric protozoa which cause waterborne disease. The detection of these organisms in water relies on the detection of the oocyst and cyst forms or stages. Monoclonal and polyclonal antibodies were compared for their abilities to react with Giardia cysts and Cryptosporidium oocysts after storage in water, 3.7% formaldehyde, and 32.5% potassium

dichromate, upon exposure to bleach, and in environmental samples. Three monoclonal antibodies to *Cryptosporidium parvum* were evaluated. Each test resulted in an equivalent detection of the oocysts after storage, after exposure to bleach, and in environmental samples. Oocyst levels declined slightly after 20 to 22 weeks of storage in water, and oocyst fluorescence and morphology were dull and atypical. Oocyst counts decreased after exposure to 2500 mg of sodium hypochlorite per liter, and fluorescence and phase-contrast counts were similar. Sediment due to algae and clays found in environmental samples interfered with the detection of oocysts on membrane filters. Two monoclonal antibodies and a polyclonal antibody directed against *Giardia lamblia* cysts were evaluated. From the same seeded preparations, significantly greater counts were obtained with the polyclonal antibody. Of the two monoclonal antibodies, one resulted in significantly lower cyst counts. In preliminary studies, the differences between antibodies were not apparent when used on the environmental wastewater samples. After 20 to 22 weeks in water, cyst levels declined significantly by 67%. Cysts were not detected with monoclonal antibodies after exposure to approximately 5000 mg of sodium hypochlorite per liter. (Author's abstract) W90-04934

COST EFFECTIVENESS OF BENTHIC FAUNAL MONITORING.
For primary bibliographic entry see Field 7A. W90-04964

DDT IN MYTILUS EDULIS: STATISTICAL CONSIDERATIONS AND INHERENT VARIABILITY.
Universidad Autonoma de Baja California (Mexico). Inst. de Investigaciones Oceanologicas. B. P. Flores Baez, and M. S. Galindo Bect.
Marine Pollution Bulletin MPNBZ, Vol. 20, No. 10, p 496-499, October 1989. 3 fig, 1 tab, 20 ref.

Descriptors: *Sampling, *Bioindicators, *Mytilus, *Mussels, *Mexico, *Pollutant identification, Mollusks, DDT, Gas chromatography, Biological samples, Statistical analysis.

The use of filter-feeding mollusks as biological indicators of coastal contamination is widely known. International monitoring programs are at present being carried out using the mussels *Mytilus edulis*, *M. californianus* and other similar species because of their ability to concentrate pollutants that are present in trace quantities in the marine environment. Samples of the mussel *Mytilus edulis* were collected from the Punta Banda Estuary, Baja California, Mexico, during the winter of 1984. The total concentration of DDT (dichlorodiphenyltrichloroethane) was determined by means of gas chromatography in samples composed of a different number of individuals (5, 10, 15, 20, and 30). It was found that 20 mussels is the optimum number of individuals to homogenize in a single sample in order to find the least analytical variability. (Mertz-PTT) W90-04965

MONITORING OF TIME TRENDS IN CONTAMINANT LEVELS USING A MULTISPECIES APPROACH: CONTAMINANT TRENDS IN ATLANTIC COD (GADUS MORHUA) AND EUROPEAN FLOUNDER (PLATICHTHYS FLEUS) ON THE BELGIAN COAST, 1978-1985.
Delaware Univ., Newark. Coll. of Marine Studies. R. K. Misra, J. F. Uthe, and W. Vynke.
Marine Pollution Bulletin MPNBZ, Vol. 20, No. 10, p 500-502, October 1989. 1 tab, 21 ref.

Descriptors: *Bioindicators, *Monitoring, *Pollutant identification, *Water pollution effects, *Fish, Cod, Flounders, Analysis of variance, Trend analysis, Belgium, International Council for the Exploration of the Sea, Statistical analysis.

The statistical procedure of analyzing for trends over time in contaminant concentrations in fish provided by the International Council for the Exploration of the Sea (1) is univariate and (2) ana-

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5A—Identification Of Pollutants

lyzes data on only one species at a time from a given sample area, even if data on more than one species are available. In this study temporal variations in contaminants in Atlantic cod (*Gadus morhua*) and European flounder (*Platichthys flesus*) from the Belgian coast are examined at the multispecies level rather than the single species level. The International Council for the Exploration of the Sea univariate procedure (1) has been extended to the analysis of combined data for the two (or more) species and (2) is supplemented by the multivariate analysis of covariance procedure. Not only did the two species respond differently to variations in contaminant levels with time but even within a species contaminant levels did not vary in the same direction. (Author's abstract)
W90-04966

INCUBATION TEMPERATURE AND THE ISOLATION OF CAMPYLOBACTER JEJUNI FROM FOOD, MILK, OR WATER.

Area Public Health Lab., Exeter (England).
T. J. Humphrey, and I. Muscat.
Letters In Applied Microbiology LAMIE7, Vol. 9, No. 4, p 137-139, October 1989. 1 tab, 8 ref.

Descriptors: *Pathogenic bacteria, *Culturing techniques, *Bacterial analysis, River water, Campylobacter, Food processing industry.

Incubation of campylobacter selective broth at 37 C for 48 h followed by selective plating and incubation at 43 C improved significantly the isolation rate of Campylobacter jejuni from naturally contaminated samples of river water and artificially contaminated samples of raw milk. The use of such a technique had no effect, however, on the isolation of C. jejuni from chicken skin. The results indicate that a period of pre-enrichment at 37 C should be considered for use with samples likely to contain sub-lethally injured cells of C. jejuni. They also demonstrate that overnight incubation in selective broth at 37 C is unlikely to lead to false negative results. With the majority of samples examined for the presence of C. jejuni the adoption of such a technique could significantly improve the isolation rate. (Author's abstract)
W90-04976

TREND MONITORING OF DISSOLVED TRACE METALS IN COASTAL SEA WATER: A WASTE OF EFFORT.

Marine Lab., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.
W90-04982

EVALUATION OF THE SENSITIVITY OF SEDIMENT STATIONS IN POLLUTION MONITORING.

Technical Univ. of Denmark, Lyngby. Inst. for Applied Geology.
B. Larsen, and A. Jensen.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 11, p 556-560, November 1989. 4 fig, 3 tab, 9 ref.

Descriptors: *Water pollution, *Monitoring, *Bottom sediments, *Lead radioisotopes, Model studies, Sediment contamination.

The value of a sediment monitoring program may be measured by its capability to reveal changes in the flux of the contaminant in question. The sensitivity of a sediment monitoring station in this respect is a function of the interactions between the change in the net deposition rate of the contaminant, the accumulation rate of the sediment, the thickness and intensity of the mixing zone in the bottom of sediment and technical factors such as time between samplings, thickness of analyzed samples, and reproducibility of the applied chemical methods. A model for these interactions computes the response of the surface sample to changes in contaminant flux over a period of time. It is based on sediment parameters which can be estimated by P-210 dating of the sediment on the site. The model offers a quantitative evaluation of a sediment monitoring station and may be applied in the planning and interpretation of sediment monitoring programs. (Author's abstract)
W90-04984

RELATIVE CONCENTRATIONS OF DISSOLVED/DISPERSED FOSSIL FUEL RESIDUES IN MEDITERRANEAN SURFACE WATERS AS MEASURED BY UV FLUORESCENCE.

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
M. Ehrhardt, and G. Petrick.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 11, p 560-565, November 1989. 4 fig, 1 tab, 12 ref.
Deutsche Forschungsgemeinschaft grant Eh 38/19-2.

Descriptors: *Water pollution, *Fuel, *Oil spills, *Chemical analysis, *Mediterranean Sea, Ultraviolet fluorescence spectroscopy.

During August-September 1987 concentrations of dissolved/dispersed petroleum residues were measured by UV fluorescence in surface waters of the eastern part of the central Mediterranean Sea. Dilute hexane solutions of a whole Agha Jari crude oil were used for instrument calibrations. Concentrations corrected for procedural blanks were in the range of several tens to less than 200 nanogram/L and increased shoreward with the exception of the sea area around 35.5 deg N 16.8 deg E, where also somewhat elevated concentrations were also encountered. A simple glass apparatus is described for collecting the lighter-than-water organic phase after extraction of lipophilic organics on the bottle used as sampler. This analytical method does not distinguish between dissolved/dispersed petroleum residues and those that are associated with fine, suspended particles. Although the dissolved/dispersed concentrations may be quite low, the extreme scarcity of particulate material in Mediterranean seawater and its higher lipophilicity, compared to water, may result in very high concentrations of petroleum residues associated with particles. Thus, low bulk concentrations may be deceptive and distract from the potentially significant environmental hazard of high concentrations of petroleum residues associated with phytoplankton. (Author's abstract)
W90-04985

TRENDS IN OIL SPILL INCIDENTS IN SOUTH AFRICAN COASTAL WATERS.

Sea Fisheries Research Inst., Rogge Bay (South Africa).
For primary bibliographic entry see Field 5B.
W90-04986

DETERMINATION OF CHLORIDE AND AVAILABLE CHLORINE IN AQUEOUS SAMPLES BY FLAME INFRARED EMISSION.

Baylor Univ., Waco, TX. Dept. of Chemistry.
For primary bibliographic entry see Field 7B.
W90-04994

EC BATHING WATER DIRECTIVE: A SAMPLING PROBLEM.

Clyde River Purification Board, East Kilbride (Scotland).
J. C. Curran.
Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 3, No. 5, p 465-466, October 1989. 1 fig, 5 ref.

Descriptors: *Pollutant identification, *European Community, *Regulations, *Sampling, *Swimming, Coastal waters, Coliforms, Interstitial water, Nearshore processes, Beaches, Monitoring, Ocean circulation, Public health, Sampling, Path of pollutants, Dye releases, Beach contamination, Water circulation, Wastewater disposal.

The relatively frequent observation, during periods of onshore drift, of a surface line of convergence in nearshore coastal waters may have significant implications for the sampling procedure used for monitoring of fecal coliforms in compliance with the EC (European Community) Bathing Water Directive. During fluorescent dye release in relatively calm coastal waters, an onshore surface current may cause the dye to approach the shore-line, yet at some distance offshore the dye patch sinks and returns seaward below the surface. A line of surface convergence is formed parallel to the

shore-line with little interaction between an inner and an outer zone of recirculation. Under conditions of stronger wave action, however, the dye will reach the foreshore. These phenomena are explained mathematically and verified by dye release studies in the Firth of Clyde in Gourock Bay. The Line of convergence for such a beach will be located in water of 2.5 m depth. This lies outside the normal depth (0.5 m to 1 m) at which shore-based sampling would be conducted for assessing compliance with the EC Bathing Water Directive on fecal coliform concentrations. If a small outfall or a stream polluted with septic tank effluent discharges at the shore-line, then high concentrations of indicator bacteria may accumulate in the near-shore waters due to the limited dilution available within the nearshore zone of recirculation. A beach may fail the Directive, although the waters at a depth appropriate for swimming may be relatively clean and well-flushed. Conversely, an effluent discharged beyond the line of convergence may not reach the foreshore during onshore drift, and water samples taken from the beach may indicate compliance with the Directive. Swimmers venturing into slightly deeper water, however, may encounter substantially higher bacterial levels. Sampling of the interstitial water which generally has a response time of several days to changes in the overlying water is suggested as a better indicator of bacterial contamination. (Geiger-PTT)
W90-05013

DIRECT DETECTION OF ORGANIC COMPOUNDS IN WATER AT PARTS-PER-BILLION LEVELS USING A SIMPLE MEMBRANE PROBE AND A QUADRUPOLE ION TRAP.

Purdue Univ., Lafayette, IN. Dept. of Chemistry.
A. K. Lister, K. V. Wood, R. G. Cooks, and K. R. Noon.
Biomedical and Environmental Mass Spectrometry BMSYAL, Vol. 18, No. 12, p 1063-1070, December 1989. 7 fig, 6 tab, 42 ref. National Science Foundation (EET-8712867).

Descriptors: *Organic compounds, *Measuring instruments, *Pollutant identification, *Water analysis, *Chemical analysis, Detection limits, Probes, Ion trap detector, Mass spectrometry.

Organic compounds present in aqueous solutions can be analyzed directly using a quadrupole ion trap detector (ITD) when the solution is introduced via a hollow fiber membrane probe. The flow-through configuration used for sample introduction allows the aqueous solution to flow through the capillary membrane tubing while the organic compounds which selectively permeate the membrane are ionized in the ion source. In this mode of operation, the instrument shows high sensitivity. Chemical ionization mass spectra for a set of ten organic compounds of environmental interest were recorded and the ITD/membrane system was found to consistently allow detection of parts-per-billion (ppb) levels of these compounds directly from water without any preconcentration. Analysis of well water samples containing ppb to parts-per-million levels of organics was demonstrated using the ITD/membrane system. The combination of the membrane probe and ion trap produces a compact, inexpensive, rapid and sensitive system for environmental analysis. The flow-through membrane configuration was also used with a direct insertion probe in a triple quadrupole. Detection limits in the ppb range for organic compounds in water were measured. Detection of particular compounds in complex matrices was demonstrated by detection of 10 ppb 2-methoxyppyridine in a fermentation medium using a triple-quadrupole mass spectrometer. (Author's abstract)
W90-05038

STUDIES ON THE EFFECT OF CELL DIVISION-INHIBITING HERBICIDES ON UNIALGAL AND MIXED ALGAL CULTURES.

Keszthely Agricultural Univ., Mosonmagyaróvár (Hungary). Inst. of Crop Production.
For primary bibliographic entry see Field 5C.
W90-05051

Identification Of Pollutants—Group 5A

TEMPORAL AND SPATIAL VARIABILITY OF ARSENIC IN BENTHIC INSECTS FROM WHITEWOOD CREEK, SOUTH DAKOTA.
For primary bibliographic entry see Field 5B.
W90-05089

DISTRIBUTION OF MAJOR AND TRACE ELEMENTS IN CORE SAMPLES FROM PICA-TINNY ARSENAL, NEW JERSEY.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05102

METHODS OF EVALUATING THE RELATION OF GROUND-WATER QUALITY TO LAND USE IN A NEW JERSEY COASTAL PLAIN AQUIFER SYSTEM.
Geological Survey, West Trenton, NJ.
E. F. Vowinkel, and W. A. Battaglin.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p405-410, 8 fig, 7 ref.

Descriptors: *Land use, *Water pollution sources, *Groundwater pollution, *New Jersey, *Nitrates, *Aquifers, Statistical analysis, Correlation analysis, Wells, Buffer zones.

Three methods were developed and tested to evaluate statistical relations of shallow groundwater quality to land use in a New Jersey Coastal Plain aquifer system: (1) The predominant land-use method; (2) Present/absent land-use method; and (3) Land-use percentage method. Each method indicates a significant relationship between nitrate nitrogen (nitrate) and purgeable organic compounds to land use. The effect of buffer radius on test results for each method was evaluated by using land-use percentages within circular buffers with radii of 1, 100, 250, 400, 600, 800, and 1,000 m about each well. The most significant relationship between constituent concentrations and land use typically are at radii of 600 or 800 meters. The study area was divided into two subareas (Area I and Area II) to determine if statistical results are similar in each area. The results for all wells are not always the same as the results for Area I and Area II. In most cases, the test results indicate that relationships for Area I are more statistically significant than those for Area II. (See also W90-05059) (Author's abstract)
W90-05105

COMPARISON OF INSTRUMENTAL DEWATERING METHODS FOR THE SEPARATION AND CONCENTRATION OF SUSPENDED SEDIMENTS.
Geological Survey, Doraville, GA.
For primary bibliographic entry see Field 7B.
W90-05112

COMPARISON OF WELL-PURGING CRITERIA FOR SAMPLING PURGEABLE ORGANIC COMPOUNDS.
Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 7B.
W90-05113

SAMPLING, FRACTIONATION, AND DEWATERING OF SUSPENDED SEDIMENT FROM THE MISSISSIPPI RIVER FOR GEOCHEMICAL AND TRACE-CONTAMINANT ANALYSIS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7B.
W90-05114

TOTAL ADENYLATE AND ADENYLATE ENERGY-CHARGE MEASUREMENTS FROM BACTERIAL COMMUNITIES IN GROUND WATER.
Geological Survey, Lakewood, CO.
M. H. Brooks, and R. L. Smith.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical

Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p541-545, 1 tab, 20 ref.

Descriptors: *Groundwater pollution, *Aquatic bacteria, *Biochemistry, *Nucleotides, *Adenylate, Wastewater, Metabolic rate, Chromatography.

Adenine nucleotides are essential biochemicals that have been used to estimate microbial biomass and metabolic state in many different ecological settings. These compounds were extracted from free-living bacteria along a longitudinal transect of a plume of sewage contaminated groundwater in an attempt to characterize the active bacterial biomass associated with the contaminant plume. Extracts were derivatized with chloroacetaldehyde and analyzed by high-performance liquid chromatography using fluorescence detection. Total adenine nucleotide concentration, an index of active biomass, decreased from 111 picomoles/L at a distance of 80 ft from the sewage source to 26 picomoles/L at a distance of 9,590 ft from the sewage source. Adenylate energy charge, an index of metabolic state, was at or near a value of 0.66 for all locations sampled within the plume of contaminated groundwater, and was independent of total adenine nucleotide concentrations. Measured adenylate energy charges were comparable to those reported for laboratory cultures in stationary growth phase and indicate the microbial communities in the contaminant plume exist at a metabolic state characterized by external stress such as nutrient limitation. (See also W90-05059) (Author's abstract)
W90-05118

PARTITIONING, DISTRIBUTION, AND RECOVERY OF DNA (DEOXYRIBONUCLEIC ACID) FROM WATER AND SEDIMENT IN A CONTAMINATED AQUIFER IN CAPE COD, MASSACHUSETTS.
Geological Survey, Menlo Park, CA.
D. W. Metzger, and R. W. Harvey.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p547-553, 2 fig, 1 tab, 11 ref.

Descriptors: *Groundwater pollution, *DNA, *Massachusetts, *Sediment analysis, *Cape Cod, *Chemical analysis, *Water analysis, Laboratory methods, Aquifers, Extraction methods, Hydrogen ion concentration, Sediments.

A method was developed for fluorometrically estimating deoxyribonucleic acid (DNA) concentrations in a contaminated, nutrient-poor sandy aquifer on Cape Cod, MA. This method was found to require alkaline extraction and phosphate buffering for efficient recovery (up to 90%) of DNA from sediment. Sediment fines (containing greater than 90% of bacterial numbers) were aseptically separated from larger grained abiotic particles by wet sieving, followed by alkaline lysis/extraction and DNA recovery. Partitioning of DNA (nonadherent extracellular DNA) compared to particle-associated extracellular DNA was estimated using measurements of well water and aquifer sediment samples. Extracellular DNA was estimated by using differences in sediment total DNA and prelysis DNAase-treated sediment samples. There was a decrease in DNA recovery, DNA/cell, and total DNA/gram of sediment coincident with decreased contaminant and nutrient concentrations over the length of the contaminant plume. Differences in recovery were found to be primarily due to pH, choice of buffer system, and sediment mineralogy. DNA/cell and DNA partitioning differences were found to be dependent upon location, nutrient conditions, and bacterial abundance. (See also W90-05059) (Author's abstract)
W90-05119

COLLECTION AND ANALYSIS OF UNSATURATED-ZONE SOIL GAS FOR VOLATILE ORGANIC COMPOUNDS.
Geological Survey, Arvada, CO.
J. A. Kammer, and J. A. Smith.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical

Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p 617-623, 2 fig, 2 tab, 5 ref.

Descriptors: *Water analysis, *Pollutant identification, *Groundwater pollution, *Volatile organic compounds, *Samplers, *Soil analysis, *Soil gases, Path of pollutants, Water pollution sources, Gas chromatography, Costs, Soil contamination.

The analysis of volatile organic compounds in soil gas plays an important role in groundwater quality studies where an understanding of contaminant fate and distribution are needed to define the extent and movement of groundwater solute plumes. A new method to sample and analyze quantitatively soil gas for the presence of volatile organic compounds is described. Soil gas is removed from the unsaturated zone through stainless-steel tubing and collected in 125 milliliter glass sampling bulbs. After sample collection, a vapor surrogate standard, bromochloromethane, is added by syringe through a septum on the side of the bulb. The sampling bulbs are transported to the laboratory where the entire contents of each bulb are purged onto an adsorbent trap and then thermally desorbed into a gas chromatograph for compound separation and quantitation. Benefits of the method include its low cost, its low analytical detection limit, its high precision, and the ability to monitor sample recovery by use of a field-spiked surrogate standard. (See also W90-05059) (Author's abstract)
W90-05126

QUANTITATION OF ACRYLAMIDE (AND POLYACRYLAMIDE): CRITICAL REVIEW OF METHODS FOR TRACE DETERMINATION/FORMULATION ANALYSIS AND FUTURE-RESEARCH RECOMMENDATIONS.
C. G. Daughton.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-121685. Price codes: A04 in paper copy, A01 in microfiche. Final Report CGD-02/88, June 23, 1988. 56p, 130 ref.

Descriptors: *Acrylamide, *Literature review, *Laboratory methods, *Pollutant identification, *Polyacrylamides, *Chemical analysis, Water treatment, High performance liquid chromatography, Gas chromatography, Research priorities, Quantitative analysis, Oil recovery, Grouting, Polarography.

During the last three decades, polyacrylamides (especially those converted to polyelectrolytes) have gained wide usage in water treatment (as flocculants/coagulants), tertiary oil recovery, and various other applications such as sewer grouts. Although the polymers are relatively nontoxic, acrylamide can elicit severe neurotoxicity and genotoxicity. For health concerns, use of polyacrylamides in drinking water has been subjected to closer evaluation during the last decade. Although numerous methods of chemical analysis exist for determining the acrylamide content of a polyacrylamide formulation, no standardized method has been adopted for directly determining 'trace' concentrations of acrylamide in water. This report presents an in-depth literature review of methods for determining acrylamide; over 100 references have been reviewed, and those that deal specifically with acrylamide determination have been annotated. The findings can be easily summarized. Initial isolation/concentration of acrylamide from water has been the most difficult task in analysis. Nearly all researchers have relied on aqueous-phase ionic bromination of the acrylyl double bond (at low pH) to form the 2,3-dibromopropionamide derivative, which has a much higher partition coefficient into organic solvents. For subsequent trace determination, two major separation methods have been evaluated—gas chromatography (GC) and high performance liquid chromatography (HPLC). For HPLC, the derivative is amenable only to non-selective UV detection (at about 200 nm) under reverse-phase separation conditions; direct determination of acrylamide itself has also been attempted. These approaches, however, have only achieved low parts per billion (micrograms/L, ug/

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L) detection limits because it has not been possible to sufficiently preconcentrate the dibromo derivative or acrylamide itself. For GC, 2,3-dibromopropionamide gives excellent detectability with electron-capture detection. Polarography or HPLC seem to be the methods of choice for formulation analysis. (Lantz-PTT)
W90-05147

DEVELOPMENT OF A MEMBRANE FOR IN-SITU OPTICAL DETECTION OF TNT.
New Hampshire Univ., Durham. Dept. of Chemistry.
Y. Zhang, W. R. Seitz, and D. D. Sundberg.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A202 306. Price codes: A02 in paper copy, A01 in microfiche. Special Report 88-24, November 1988. 6p, 8 fig, 1 tab, 6 ref.

Descriptors: *Pollutant identification, *Trinitrotoluene, *In situ tests, *Membranes, Aromatic compounds, Hydrocarbons, Organic compounds, Chemical analysis, Trinitrobenzene, Groundwater pollution, Water analysis.

One of the Army's most serious water pollution problems is how to dispose of wash waters used to clean equipment and interior surfaces at munitions manufacturing and demilitarization facilities. Because of the possibility that these munitions can reach groundwater it is necessary for the Army to periodically determine whether groundwater has been contaminated. The goal of this project was to develop a system for in-situ optical detection and estimation of 2,4,6-trinitrotoluene (TNT) in groundwater, which would reduce the need to collect groundwater samples for laboratory analysis. A membrane was developed for in situ determination of polynitroaromatic hydrocarbons in groundwater at levels as low as 10 nanograms/ml (ng/ml). A typical membrane is prepared by dissolving the following in tetrahydrofuran: 0.5 g polyvinyl chloride (PVC), 0.2 ml dioctylphthalate to serve as a plasticizer and 0.12 ml Jeffamine T403, a polyoxyethyleneamine that also acts as a plasticizer, as well as reacting with polynitroaromatic hydrocarbons to produce a colored product. The membrane is formed by casting the solution into a glass Petri dish with a diameter of 8 cm and allowing the solvent to slowly evaporate. Trace amounts of 2,4,6-trinitrotoluene (TNT), 1,3,5-trinitrobenzene (TNB), 2,4,5-trinitrotoluene (2,4,5-TNT), and methyl-2,4,6-trinitrophenyl nitramine (tetryl) react with the membrane to produce a visually observable reddish brown color. No pretreatment of water samples is required. Recoveries of 0.1 to 4.0 parts per million TNT from spiked groundwater ranged from 95% to 105%. Direct analysis of water samples agreed with high performance liquid chromatography results. (Lantz-PTT)
W90-05166

RESULTS OF HYDROLOGIC RESEARCH AT A LOW-LEVEL RADIOACTIVE-WASTE DISPOSAL SITE NEAR SHEFFIELD, ILLINOIS.
Geological Survey, Champaign, IL. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-05221

INVENTORY AND EVALUATION OF BIOLOGICAL INVESTIGATIONS THAT RELATE TO STREAM-WATER QUALITY IN THE UPPER ILLINOIS RIVER BASIN OF ILLINOIS, INDIANA, AND WISCONSIN.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5C.
W90-05224

EVALUATION OF FIELD SAMPLING AND PRESERVATION METHODS FOR STRONTIUM-90 IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.
Geological Survey, Idaho Falls, ID. Water Resources Div.

L. D. Cecil, L. L. Knobel, S. J. Wegner, and L. L. Moore.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4146, 1989. 24p, 2 fig, 6 tab, 13 ref.

Descriptors: *Quality control, *Water analysis, *Pollutant identification, *Strontium radioisotopes, *Idaho, Statistical analysis, Data collections.

Water from four wells completed in the Snake River Plain aquifer was sampled as part of the U.S. Geological Survey's quality assurance program to evaluate the effect of filtration and preservation methods on strontium-90 concentrations in groundwater at the Idaho National Engineering Laboratory. Water from each well was filtered through either a 0.45-micrometer membrane or a 0.1-micrometer membrane filter; unfiltered samples also were collected. Two sets of filtered and two sets of unfiltered samples was preserved in the field with reagent-grade hydrochloric acid and the other set of samples was not acidified. For water from wells with strontium-90 concentrations at or above the reporting level, 94% or more of the strontium-90 is in true solution or in colloidal particles smaller than 0.1 micrometer. These results suggest that within-laboratory reproducibility for strontium-90 in groundwater at the INEL is not significantly affected by changes in filtration and preservation methods used for sample collections. (USGS)
W90-05278

DETERMINATION OF LOW LEVEL SULFIDES IN ENVIRONMENTAL WATERS BY AUTOMATED GAS DIALYSIS/METHYLENE BLUE COLORIMETRY.

Alberta Environmental Centre, Vegreville.
D. Francom, L. R. Goodwin, and F. P. Dieken.
Analytical Letters ANALBP, Vol. 22, No. 11/12, p 2587-2600, September/October 1989.

Descriptors: *Sulfides, *Pollutant identification, *Chemical analysis, *Colorimetry, *Laboratory equipment, *Gas dialysis, Aquatic environment, Water sampling, Automation, Dyes, Copper, Chemical interference, Detection limits.

There are numerous procedures available for the determination of sulfide in aqueous samples. Methods investigated are subject to high detection limits, are time consuming, not suitable for zinc-preserved samples, or their accuracy is complicated by the presence of established interferences. A sensitive and rapid automated method was developed for the selective analysis of acid extractable sulfide in environmental samples by combining gas dialysis separation techniques with methylene blue detection procedures. Acid extractable sulfide is separated from the sample matrix by the gas dialysis membrane and subsequently trapped in a dilute sodium hydroxide receiving stream. This stream is reacted with N,N-dimethyl-p-phenylenediamine and ferric chloride to produce methylene blue which is then quantitated colorimetrically at 660 nm. For standards and nonturbid environmental samples, there is good agreement between the results obtained by this procedure and the standard methylene blue method. The effects of interferences on the accurate determination of sulfide by both methods were also examined and it was found that cupric ions significantly interfered with sulfide estimation. To obtain adequate sulfide recoveries in tap water and environmental samples, ascorbic acid must be added as an antioxidant. A detection limit of 2 microg/L of sulfide has been obtained using this procedure. (Author's abstract)
W90-05312

IMMOBILIZED 8-OXINE UNITS OF DIFFERENT SOLID SUPPORTS FOR THE UPTAKE OF METAL TRACES.
Turin Univ. (Italy). Dipt. di Chimica Analitica.
For primary bibliographic entry see Field 7B.
W90-05313

GAS-CHROMATOGRAPHIC ANALYSIS OF CHLORINATED ACIDS IN DRINKING WATER.

Glenmore Waterworks Lab., Calgary (Alberta).
E. E. Hargreaves, and T. Satchell.
Aqua AQUAAA, Vol. 30, No. 6, p 345-351, December 1989. 5 fig, 1 tab, 20 ref.

Descriptors: *Chlorinated carboxylic acids, *Chemical analysis, *Drinking water, *Gas chromatography, *Pollutant identification, Detection limits, Resins, Reproducibility, Acetic acid, Dichloroacetic acid, Trichloroacetic acid.

Determination of chlorinated organic compounds in treated drinking water is important as many of these are suspected or confirmed carcinogens. Trihalomethanes are routinely determined in drinking water, however simple gas-chromatographic methods for analysis of microgram/L concentrations of non-volatile, highly soluble chlorinated carboxylic acids are not well established. A simple method for the isolation and quantification of dichloroacetic acid (DCAA) and trichloroacetic acid (TCAA) by capillary gas chromatography with electron-capture detection (GC-ECD) was developed. DCAA and TCAA were isolated from water using a Dowex-1-chloride anion-exchange resin followed by acid elution and solvent extraction of the acidic aqueous eluent with diethyl ether. The acids were esterified with BF₃-methanol prior to GC-ECD. Bromoacetic acid was used as internal standard to quantify DCAA and TCAA. Method reproducibility was good, with a detection limit of 0.1 micrograms/L for both TCAA and DCAA. Compound identities were confirmed by gas chromatography-mass spectrometry. The method was applied to the quantitative analysis of chlorinated acids in drinking water. (Author's abstract)
W90-05316

MICROBIOLOGY OF BOTTLED NATURAL MINERAL WATERS.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5B.
W90-05374

LOSS OF TOTAL SULFUR AND CHANGES IN SULFUR ISOTOPIC RATIOS DUE TO DRYING OF LACUSTRINE SEDIMENTS.

Manitoba Univ., Winnipeg. Dept. of Microbiology
For primary bibliographic entry see Field 2H.
W90-05402

LEVELS OF HEAVY METALS IN SOME RED SEA FISH BEFORE HOT BRINE POOLS MINING.

State Pollution Control Commission, Sydney (Australia).
For primary bibliographic entry see Field 5B.
W90-05412

USE OF BIODETECTORS AS 'CHANNEL SPY' TO ENCIRCLE NON-LEGAL HEAVY METAL DISCHARGES IN SEWERS (EINSATZ EINES BIODETEKTORS ALS KANALSPION ZUM NACHWEIS DER SCHWERMETALLHERKUNFT IN ABWASSERSIELEN).

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
W. Kienz, W. Ahlf, W. Calmano, and U. Forstner.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 239-244, December 1989. 5 fig, 2 tab, 27 ref. English summary.

Descriptors: *Bioindicators, *Water pollution sources, *Monitoring, *Path of pollutants, *Heavy metals, *Wastewater analysis, *Mosses, Bioaccumulation, Absorption.

It had been difficult to determine the sources of heavy metal pollutants in wastewater treatment systems. A possible way for localization of heavy metal contaminated discharges into the sewer is based on biological monitoring and the high accumulation of heavy metals on moss (*Sphagnum recurvum*). In laboratory and field experiments a distinct accumulation of heavy metals on moss was indicated; the uptake of heavy metals is fast so that short-term impacts may be detected. Metal paths

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can be determined by comparison of three samples on a sewer branch. The method allows the fast, easy and unobserved encirclement of dischargers. (Author's abstract)
W90-05418

STREAMING CURRENT DETECTION FOR DETERMINATION OF METAL COMPLEXATION CAPACITIES OF AQUATIC HUMIC SUBSTANCES.

Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
M. Weis, F. S. Valera, and F. H. Frimmel.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 253-257, December 1989. 6 fig, 1 tab, 23 ref. Deutsche Forschungsgemeinschaft Grant FR 536/9.

Descriptors: *Metal complexes, *Humic acids, *Copper, *Organic matter, *Pollutant identification, Leachates, Polarographic analysis, Laboratory methods, Adsorption, Electrolytes.

Cu(II) complexation capacities of aquatic organic matter isolated by the XAD-method were determined by means of streaming current detection. The new dissolved organic carbon (DOC)-intrinsic technique is based on the titration of humic anions by cationic polyelectrolyte. The Cu(II) complexation capacities are calculated from the volume of titer consumed to reach the isoelectric point of detected net charge for solutions with various ratios of Cu(II) complexation capacities to humic substances. The Cu(II) complexation capacities values of humic-like substances isolated from landfill leachates (0.5-1.4 micromoles Cu(II)/mg DOC) are within the range of those determined by differential pulse polarography (0.5-2.3 micromoles Cu(II)/mg DOC). The plots of charge density vs. metal concentration reflect the complexation reactions. The method can be applied to the complexation of all metals because it is DOC-intrinsic and therefore independent from metal analysis. (Author's abstract)
W90-05421

DETERMINATION OF CHLOROPHENOLS IN AQUEOUS, SOLID AND GAS SAMPLES BY GC/ECD AND GC/MS.

Tuebingen Univ. (Germany, F.R.). Inst. fuer Organische Chemie.
F. Tschöchner, W. Pilz-Mittenburg, T. Benz, H. Brunner, and W. Jaeger.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 267-271, December 1989. 4 fig, 4 tab, 5 ref.

Descriptors: *Chemical analysis, *Phenols, *Chlorinated hydrocarbons, *Pollutant identification, *Gas chromatography, *Mass spectrometry, Column chromatography, Separation techniques, Sludge analysis, Detection limits.

Chlorophenols can be analyzed very effectively as acetyl derivatives. After acid extraction, the chlorophenols are reextracted into a solution of potassium carbonate. The chlorophenols are subsequently acetylated with acetic anhydride and extracted with hexane. Gas chromatographic separation is carried out on a DB-5 capillary column. The analysis of chlorophenols as acetyl derivatives is superior to the analysis of underivatized chlorophenols, since the acetates can be readily purified by a chromatographic step, eliminating interferences. Detection by both electron capture and mass spectrometry was evaluated, the latter being the method of choice. The detection limit with electron capture detection is about 0.05 micrograms/sample for the tri- to pentachlorophenols, if 5 ml hexane are used for the extraction of the acetates. For monochlorophenols the detection limit is at least a factor 10 higher. For the mass spectrometric detection, the sample volume has to be reduced considerably compared to ECD detection. With the volume reduced to about 0.1 ml and with the GC/MS system used, the detection limit is about 1 nanogram/sample for the monochlorophenols to pentachlorophenols. Results of chlorophenol determinations on a compost sample and a sewage sludge sample using GC/MS analysis is reported. (Geiger-PTT)

W90-05424

DETECTION OF COLIPHAGES AND ENTEROVIRUSES IN DRINKING WATER AND ITS SOURCES.

Vyskumny Ustav Preventivneho Lekarstva, Bratislava (Czechoslovakia).
A. Petrovicova.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 285-287, November 1989. 1 tab, 3 ref.

Descriptors: *Bacteriophage, *Enteroviruses, *Drinking water contamination, *Water analysis, *Water quality, *Water treatment, Laboratory methods.

A longitudinal study on the use of quantitative detection of coliphages as indicators of viral contamination of treated drinking water was carried out. The double agar layer method, using *Escherichia coli* strains B-39 and K-12-Z-2, was used as a system of coliphage detection by plaque counting. The quantitative coliphage assay in raw and treated water indicated the efficiency of the water treatment process. Where slight or no decrease of the coliphage number was found, the regime of the plant was checked; after correcting faults in the treatment process, the quality of the treated drinking water was often improved. No enteroviruses were found in water samples where no coliphages were present. The presence of coliphages in treated water was often found together with enteroviruses. The results indicate that coliphages in drinking water can be considered indicative of enteroviral contamination. (Sand-PTT)
W90-05481

NEW SCREENING TEST TO DETERMINE THE ACCEPTABILITY OF 0.45-MICRON MEMBRANE FILTERS FOR ANALYSIS OF WATER.

Environmental Monitoring Systems Lab., Cincinnati, OH.
K. P. Brenner, and C. C. Rankin.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 54-64, January 1990. 2 fig, 4 tab, 32 ref.

Descriptors: *Water quality control, *Culturing techniques, *Quality control, *Bacterial analysis, *Membrane filters, *Coliforms, *Klebsiella, *Enterobacter, Monitoring, Comparison studies, *Escherichia coli*, *Citrobacter*.

During routine membrane filter (MF) quality control testing, irregularities such as partial or complete inhibition of microbial growth at gridlines, abnormal spreading of colonies, growth in or along the grid lines, nonwetting areas, poor colony sheen and metallic sheen on the MF surface with mEndo agar, brittleness, decreased recovery, and severe wrinkling were observed with several lots of filters. To study these effects and to develop a more sensitive screening test for MF quality, 5 different MFs with various types and degrees of defects were compared by using 5 stock coliform cultures and 5 different media. The *Enterobacter aerogenes*-tryptic soy agar test system detected more MF defects than any other combination and was superior to the *Escherichia coli*-mFC agar American Society for Testing and Materials method for grid line inhibition. Filtered natural samples grown on the same media showed the same effects as were observed with the pure cultures. Poor colony sheen and sheen on the MF surface were best detected with *Enterobacter aerogenes* on mEndo agar. The use of tryptic soy agar and mEndo agar with this organism permitted the maximum detection of MF irregularities. Of the 142 MF lots tested by this method, 30% were acceptable, 10% were marginally acceptable, and 61% were unacceptable. This method provides a valuable screening test for determining the acceptability of 0.45-micron-pore-size MFs used for coliform and heterotroph analysis and may also be useful in conjunction with other methods. (Author's abstract)
W90-05482

SIMPLE MEDIUM THAT PRESERVES LOW CONCENTRATIONS OF ESCHERICHIA COLI

FOR USE IN THE WATER BACTERIOLOGY PROFICIENCY TEST.

New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.

M. Chen.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 146-149, January 1990. 1 fig, 7 tab, 5 ref.

Descriptors: *Culturing techniques, *Water quality control, *Bacterial analysis, *Coliforms, *Escherichia coli, Potable water, Proficiency testing.

A medium containing (per liter) 6.8 g of sodium acetate trihydrate, 3.4 g of potassium dihydrogen phosphate, and 0.1 g of magnesium sulfate heptahydrate (medium pH, 5.85 \pm 0.05) was developed for use in a water bacteriology proficiency test. The medium maintained 80-100% viability of inoculated *Escherichia coli* at temperatures up to 31°C for at least 12 days, while the concentrations of bacteria in the medium were as low as 20 bacteria/100 ml. The medium remained stable after a year in storage. It has been used successfully to preserve bacteria in 9 statewide bacteriology proficiency tests for potable and nonpotable water and has also been used in a nationwide pilot test. (Author's abstract)
W90-05484

USEPA METHOD STUDY 39, METHOD 504, 1,2-DIBROMOETHANE (EDB) AND 1,2-DIBROMO-3-CHLOROPROPANE (DBCP) IN WATER BY MICROEXTRACTION AND GAS CHROMATOGRAPHY.

Bionetics Corp., Cincinnati, OH.
K. W. Edgell.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-119580. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/4-88/034, October 1988. 52p, 4 tab, 6 ref. EPA Contract 68-03-3254.

Descriptors: *Water analysis, *Testing procedures, *Pollutant identification, *Organic compounds, *Chemical analysis, Volatile organic compounds, Dibromomethane, Chloropropane, Gas chromatography, Statistical analysis, Quality control.

An interlaboratory collaborative study was conducted to determine the precision and bias (recovery) of Method 504 for the analysis of two semi-volatile organic compounds in groundwater. Method 504 is entitled '1,2-Dibromoethane and 1,2-Dibromo-3-chloropropane in Water by Microextraction and Gas Chromatography', and includes instructions for quality control, sample preparation and analyses of samples by gas chromatography. A detailed investigation of the number of outliers is a good measurement of the ruggedness of the method. In this study, 15% of the submitted data points were rejected as outliers. The laboratory ranking test, associated with systematic errors, represented 67% of the total rejected data while the individual outlier test accounted for the remaining 33%. One laboratory accounted for 41% of the total outliers while 7 laboratories had no outliers for 1,2-dibromoethane and 8 laboratories had no outliers for 1,2-dibromo-3-chloropropane. The groundwater produced no apparent matrix effect on the number of outliers (7.1% outliers in reagent water and 7.9% outliers in groundwater). The relatively low percentage of outlier data indicated that the method is rugged. The recovery of the method was obtained by comparing the mean values from the study to the true value concentrations. Recoveries of 107% and 108% for reagent water and groundwater were found for 1,2-dibromoethane. For 1,2-dibromo-3-chloropropane recoveries of 99% and 97% were found for reagent water and groundwater, respectively. The overall standard deviation expressed as the percent relative standard deviation (%RSD) was 8% for 1,2-dibromoethane in reagent water and groundwater respectively. The %RSD was 14% and 16% for 1,2-dibromo-3-chloropropane in reagent water and groundwater respectively. The single-analyst standard deviation expressed as the percent relative standard deviation (%RSD-SA) was 4% and 5% for 1,2-dibromoethane in reagent water and groundwater and 7% and 8% for 1,2-

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dibromo-3-chloropropane in reagent water and groundwater respectively. (Lantz-PTT) W90-05557

MONITORING FOR VOLATILE ORGANICS IN EFFERVESCENT GROUND WATER.

Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant. W. Fay, R. Lorenz, V. Jones, W. Colven, and B. Looney.

Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016909. Price codes: A02 in paper copy, A01 in microfiche. Report No. DP-MS-86-12, (1988). 9p, 2 fig, 6 ref.

Descriptors: *Water pollution control, *Volatile organic compounds, *Groundwater quality, *Effervescence, *Pollutant identification, *Samplers, Groundwater pollution, Aquifers, Water sampling, Measuring instruments, Chisamar sampler, Trichloroethylene, Trichloroethane, Tetrachloroethylene.

Water from aquifers under pressure and saturated in nitrogen, carbon dioxide, hydrogen, or other gases effervesces at atmospheric pressure. This effervescence removes volatile organics, causing water exposed to atmospheric pressure to be unrepresentative of the groundwater. The results of any sampling method that exposes the water to the atmosphere are distorted no matter how carefully the sample is collected. Appropriate samples can be collected using down-hole samplers that are retrieved without exposure to the atmosphere or using bomb samplers for pumping wells. DuPont at the Savannah River Plant has developed the Chisamar sampler, which is an appropriate bomb sampler. The sampling device is a steel tube with gas-tight ball valves at either end. When the ball valves are open, the sampler has a uniform 0.5-in. diameter interior that allows unobstructed flow of water through the device. Water is pumped through the sampler to reach equilibrium; then the valves are closed simultaneously, capturing a representative sample of the gas and water. The organics and gases are purged from the sampler into an inflatable sample container. Aliquots of the gas are analyzed by gas chromatography. The Chisamar sampler has been tested in an area of known trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane groundwater contamination. The Chisamar sampler yields results comparable to other sampling techniques on groundwater from an unconfined aquifer. In wells monitoring confined aquifers under 150 ft of head, volatile organics are detected in samples collected with the Chisamar sampler but are not detected in samples collected by bailing or syringe samplers that expose the sample to the atmosphere. This device may be the only appropriate method of sampling water supply wells that are inaccessible to downhole devices. (Author's abstract) W90-05581

GROUND-WATER MONITORING COMPLIANCE PROJECT FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. Battelle Pacific Northwest Labs., Richland, WA. Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016531. Price codes: A06 in paper copy, A01 in microfiche. Volume 1-Text. Report No. PNL-6581-Vol.1, May 1988. 106p, 19 fig, 24 tab, 13 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Washington, *Data collections, *Groundwater quality, *Water quality control, *Monitoring, Hanford Site, Monitoring wells.

The progress of eight Hanford Site groundwater monitoring projects for the period January 1 to March 31, 1988 is presented. The facilities represented by the eight projects are the 300 Area Process Trenches, 183-H Solar Evaporation Basins, 200 Areas Low-Level Burial Grounds, Nonradioactive Dangerous Waste Landfill, 216-A-36B Crib, 1301-N Liquid Waste Disposal Facility, 1325-N Liquid Waste Disposal Facility, and 1324-N/NA Surface Impoundment and Percolation Ponds. The latter four projects are included in this series of quarterly reports for the first time. During

the period, field activity at the 300 Area Process Trenches and 183-H Solar Evaporation Basins consisted of scheduled monitoring of liquid levels and collection and analysis of water samples. At the 200 Areas Low-Level Burial Grounds, wells constructed during the previous quarter were further inspected and developed. At the 216-A-36B Crib, five new monitoring wells were initiated, and one of these was completed during this quarter. Sampling and analysis were conducted on four wells surrounding the 1324-N/NA ponds during December 1987 and this first quarter of 1988. None of the wells sampled and analyzed during this quarter exceeded the EPA drinking water standards. Five new monitoring wells were completed in the 100-N Area, and quarterly sampling commenced in December 1987. (Author's abstract) W90-05585

APPLICATION OF THE 'MASTER ANALYTICAL SCHEME' TO INFLUENT AND EFFLUENT WASTEWATERS.

Research Triangle Inst., Research Triangle Park, NC.

D. L. Norwood, L. C. Michael, S. D. Cooper, T. W. Pack, and M. E. Montgomery. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129423. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/248, November 1988. 22p, 6 fig, 4 tab, 6 ref. EPA Contract 68-01-6904.

Descriptors: *Pollutant identification, *Water quality control, *Effluents, *Wastewater treatment, Organic compounds, Testing procedures, Organic acids, Quality control, Standards.

The Master Analytical Scheme for Organics in Water (MAS) was applied to samples of influent and effluent wastewaters obtained from a series of municipal wastewater treatment works. The results were expected to provide an indication of treatment efficiency relative to micropollutant content. For each influent and effluent sample pair, the complete MAS was applied. In each individual protocol, target compounds were searched for and quantified using a current database of relative molar response values. In each case, the effluent wastewater is significantly reduced in both total amount and total numbers of micropollutants relative to the corresponding influent wastewater. The MAS analyses have clearly provided an indication of micropollutant treatment efficiency for these four plants. In the effluent, organic acids are virtually eliminated and the generally lower molecular weight volatile organics are of greater relative importance. As with any comprehensive scheme for trace organic analysis of complex mixtures derived from environmental matrices, the MAS is not without problems. However, unlike many such schemes the MAS incorporate sufficient quality assurance procedures to allow problems to be identified and their causes indicated. The use of isotope labeled internal standards for each micropollutant class spiked into the aqueous matrix before any extraction steps allows an assessment of analyte recoveries. External standards added to the extracts assess gas chromatography/mass spectrometry/data system performance during individual sample analyses and are utilized for recovery calculations. (Lantz-PTT) W90-05591

APPLICABILITY OF AMBIENT TOXICITY TESTING TO NATIONAL OR REGIONAL WATER-QUALITY ASSESSMENT.

Geological Survey, Madison, WI. Water Resources Div.

J. F. Elder. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-55, 1989. 102p, 3 fig, 21 tab, 910 ref, append.

Descriptors: *Water analysis, *Bioassay, *Water quality, *Toxicity, *Water quality standards, Biological studies, Testing procedures, Biochemistry, Environmental quality.

Comprehensive assessment of the quality of natural waters requires a multifaceted approach. Based on

experimentation designed to monitor responses of organisms to environmental stresses, toxicity testing may have diverse purposes in water quality assessments. These purposes may include identification that warrant further study because of poor water quality or unusual ecological features, verification of other types of monitoring, or assessment of contaminant effects on aquatic communities. A wide variety of toxicity test methods have been developed to fulfill the needs of diverse applications. The methods differ primarily in the full selections made relative to four characteristics: (1) test species, (2) endpoints (acute or chronic), (3) test enclosure type, and (4) test substance (toxicant) that functions as the environmental stress. Toxicity test approaches vary in their capacity to meet the needs of large-scale assessments of existing water quality. Ambient testing is more likely to meet these needs than are the procedures that call for exposure of the test organisms to known concentrations of a single toxicant. However, meaningful interpretation of ambient test results depend on the existence of accompanying chemical analysis of the ambient media. The ambient test substance may be water or sediments. Sediment tests have had limited application, but they are useful because of the fact that most toxicants tend to accumulate in sediments, and many test species either inhabit the sediments or are in frequent contact with them. Biochemical testing methods, which have been developing rapidly in recent years, are likely to be among the most useful procedures for large-scale water quality assessments. They are relatively rapid and simple, and more importantly, they focus on biochemical changes that are the initial responses of virtually all organisms to environmental stimuli. Most species are sensitive to relatively few toxicants and their sensitivities vary as conditions change. One of the most informative approaches for toxicity testing is to combine biochemical tests with other test methods in a 'battery or tests' that is diversified enough to characterize different types of toxicants and different trophic levels. (Lantz-PTT) W90-05594

QUALITY-ASSURANCE DATA FOR ROUTINE WATER ANALYSIS IN THE NATIONAL WATER-QUALITY LABORATORY OF THE U.S. GEOLOGICAL SURVEY FOR THE YEAR 1988.

Geological Survey, Denver, CO. Water Resources Div.

For primary bibliographic entry see Field 7B. W90-05607

YIELD AND QUALITY OF GROUND WATER FROM STRATIFIED-DRIFT AQUIFERS, TAUNTON RIVER BASIN, MASSACHUSETTS: EXECUTIVE SUMMARY.

Geological Survey, Boston, MA. Water Resources Div.

For primary bibliographic entry see Field 2F. W90-05615

EVALUATION OF METHODS USED FROM 1965 THROUGH 1982 TO DETERMINE INORGANIC CONSTITUENTS IN WATER SAMPLES.

For primary bibliographic entry see Field 7B. W90-05619

5B. Sources Of Pollution

TRANSFER OF RADIOCESIUM FROM DIFFERENT ENVIRONMENTAL SOURCES TO EWES AND SUCKLING LAMBS.

Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station. B. J. Howard, R. W. Mayes, N. A. Beresford, and C. S. Lamb. Health Physics HLTPAO, Vol. 57, No. 4, p 579-586, October 1989. 1 fig, 6 tab, 17 ref.

Descriptors: *Path of pollutants, *Cesium radioisotopes, *Sheep, *Bioaccumulation, *Animal tissues, *Fallout, Population exposure, Animal popula-

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tions, Absorption, Radioisotopes, Radioactive wastes.

Indoor experiments were conducted to compare the transfer of radioiodine to ewe and lamb tissues from different sources. Lactating ewes were fed either perennial ryegrass contaminated by Chernobyl fallout, or saltmarsh vegetation contaminated by marine discharges from the Sellafield reprocessing plant. The transfer to ewe tissues and milk was greater from the Chernobyl contaminated herbage than from saltmarsh vegetation. Lambs receiving a mixture of vegetation and milk were given radioiodine from one of the two vegetation sources or from milk obtained from the experimental ewes. Transfer to lamb tissues declined in the order milk > Chernobyl fallout > Sellafield discharge. The radioiodine transfer to lamb tissues exceeded that to ewe tissues. Transfer coefficients for Cs137 in the Chernobyl fallout were higher than most previously published figures at 0.12 d/kg for ewe muscle and 0.50 d/kg for lamb muscle. The transfer coefficient for Cs137 from ewe milk to lamb was 1.20 d/kg. (Author's abstract) W90-04557

PLUTONIUM DISTRIBUTION AND OXIDATION STATES IN A REACTOR LEACHING PONDS SYSTEM.

Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology. S. Ibrahim, and T. Culp. Health Physics HLTPO, Vol. 57, No. 4, p. 607-614, October 1989. 1 fig, 5 tab, 25 ref. DOE contract DE-A507-76ID01526.

Descriptors: *Radioactive waste disposal, *Path of pollutants, *Plutonium, *Radioisotopes, *Radioactive wastes, Particulate matter, Zooplankton, Sediments, Idaho.

Concentrations of Pu239,240 and Pu238 in water, net plankton (algal material), suspended particulates and sediment, as well as Pu oxidation states in filtered water, were determined in a test reactor leaching ponds system in southeastern Idaho. The highest Pu concentration in the ponds system was found in net plankton, and concentrations varied significantly between sampling dates. Plutonium Concentration Ratios (CR) for plankton ranged from 30,000 to 400,000. The lowest Pu concentration was found in filtered water, primarily because of the absence of complexing agents. The majority of Pu in filtered water was in true solution (60-87%) or present in colloidal particles smaller than 0.22 microns. Plutonium association with sediment was inversely related to particle size. The 'environmental' distribution coefficients for Pu ranged from 16,000 to 120,000, reflecting the importance of sediments as the main reservoir for Pu in the ponds system. No significant differences were noted between CR or distribution coefficients for Pu239,240 and Pu238. The reduced oxidation states (III and IV) fractions ranged from 57% to 71% of the total dissolved Pu in water. This is in contrast with oxidation states distribution from other large aquatic systems (Great Lakes and the Irish Sea) where Pu is predominately in oxidized (V and VI) forms. (Author's abstract) W90-04558

ACID DEPOSITION MODELING AND THE INTERPRETATION OF THE UNITED KINGDOM SECONDARY PRECIPITATION NETWORK DATA.

Hull Univ. (England). Dept. of Geography. S. E. Metcalfe, D. H. F. Atkins, and R. G. Derwent. Atmospheric Environment ATENBP, Vol. 23, No. 9, p. 2033-2052, September 1989. 18 fig, 7 tab, 31 ref.

Descriptors: *Path of pollutants, *Model studies, *Acid rain, *Air pollution, *Sulfates, *Nitrates, *Chemistry of precipitation, Atmosphere, Air circulation, Model testing, United Kingdom, Ammonium.

Acid deposition modeling calculations have been compared against the data obtained during the first year's operation of the United Kingdom Secondary

Precipitation Network. The model adopted employed a single level trajectory approach to describe the coupled atmospheric chemistry and deposition of SO_x, NO_y, and NO_x species. For the precipitation sulfate concentrations, the model results for the 47 network sites correlated well with the observations. When corrections were applied within the model calculations for background deposition and for dry deposition into the bulk collector, the model results overestimated the precipitation sulfate observations by about 27%. For the precipitation nitrate concentrations, again the model results correlated well with the observations. Over the whole network, the model underestimated the observations by about 6% and no significant background correction was required for background sources. For the precipitation ammonia concentrations, good agreement with the observations could only be obtained if an additional ammonia source over and above that from animal manure was included in the model. One possibility investigated was exhalation from agricultural soils with an emission rate of 50-100 kg NH₃/ha/a. The model was able to reproduce the main features of the distributions of NO₂ and NH₃ in terms of gradients across the U.K. and in the location of the respective maxima. However, in both cases, severe underestimation by the model was apparent. The source of this underestimation was found to involve the assumption of complete vertical mixing in the model and the neglect of nocturnal stable layers. (Author's abstract) W90-04579

GENERALIZED MULTIDIMENSIONAL MODEL FOR PRECIPITATION SCAVENGING AND ATMOSPHERIC CHEMISTRY.

Battelle Pacific Northwest Labs., Richland, WA. J. M. Hales. Atmospheric Environment ATENBP, Vol. 23, No. 9, p. 2017-2031, September 1989. 5 fig, 3 tab, 30 ref, append.

Descriptors: *Model studies, *Path of pollutants, *Air pollution, *Chemistry of precipitation, *Acid rain, *Precipitation, Clouds, Atmosphere, Storms, Weather, Atmospheric physics, Air circulation.

A new, general-purpose computer code was developed for modeling air pollutants both in the gas phase and in conjunction with cloud and precipitation systems. The code is based on Eulerian representations of conservation equations for chemical species, energy, and the physical media (e.g. air, cloud, water, rain water ice,...) in which the chemical species reside. Because energy and moisture conservation equations are included, the code is capable of simulating cloud and storm formation, and can deal directly with the attachment, wet-chemistry and deposition processes associated with precipitation systems. The code has been structured to allow considerable flexibility in its use. One, two, or three-dimensional simulations can be performed, and selection of modeled chemical species, physical media, physicochemical interaction mechanisms, spatial/temporal domain and grid spacing is at the option of the user. A simple example simulation, corresponding to the scavenging of sulfur and nitrogen oxides in a frontal storm system is presented to illustrate the code's use. (Author's abstract) W90-04580

MODELING OF ATMOSPHERIC TRANSPORT AND DEPOSITION OF TOXAPHENE INTO THE GREAT LAKES ECOSYSTEM.

Atmospheric Environment Service, Downsview (Ontario). E. C. Voldner, and W. H. Schroeder. Atmospheric Environment ATENBP, Vol. 23, No. 9, p. 1949-1961, September 1989. 4 fig, 4 tab, 85 ref.

Descriptors: *Model studies, *Air pollution, *Pesticides, *Toxaphene, *Path of pollutants, *Fate of pollutants, *Great Lakes, Toxicity, Aquatic environment, Atmosphere, Air circulation.

Toxaphene, not extensively used in the Great Lakes basin, has been found in fish, lake water, ambient air and precipitation in this region. It has been suggested that the atmosphere constitutes a

primary transport route of toxaphene to the Great Lakes from the major source regions in the southern United States. Environmental measurements are too few to estimate the input of toxaphene to the Great Lakes basins. The ASTRAP model, used in acid rain research, was modified for simulation of the atmospheric pathway of toxaphene. Based on emission inventories, derived from use patterns in North America for 1976 and 1980, air concentration and deposition of toxaphene to the Great Lakes were estimated. The results confirm that the atmosphere is a major transport route of toxaphene to the Great Lakes region. They also show that toxaphene can be transported to the North Atlantic. Total deposition to the Lakes in 1980 was 3-10 t and annual average air concentrations about 0.5 ng/cu m. Although the information on physical/chemical properties and emissions is incomplete and air quality and precipitation chemistry measurements of toxaphene are few and uncertain, model predictions show good agreement with the measurements. (Author's abstract) W90-04581

INTERCOMPARISON OF LONG-TERM ATMOSPHERIC TRANSPORT MODELS; THE BUDGETS OF ACIDIFYING SPECIES FOR THE NETHERLANDS.

UKAEA Atomic Energy Research Establishment, Harwell (England). Environmental and Medical Sciences Div.

R. G. Derwent, O. Hov, W. A. H. Asman, J. A. van Jaarsveld, and F. A. A. de Leeuw. Atmospheric Environment ATENBP, Vol. 23, No. 9, p. 1893-1909, September 1989. 4 fig, 7 tab, 51 ref, append.

Descriptors: *Model studies, *Acid rain, *The Netherlands, *Air pollution, *Path of pollutants, *Air circulation, Meteorological data collection, Atmosphere, Chemistry of precipitation, Model testing.

An intercomparison is provided between the deposition budgets for a range of acidifying species for The Netherlands inferred from airborne and precipitation concentrations with those calculated in four long-term atmospheric transport models. Differences are found in the magnitudes of the deposition fluxes between the species, between deposition routes and for the contributions from the various source areas. The origins of the discrepancies are investigated in terms of the meteorological and chemical formulations of the models, and their extents of temporal, vertical and horizontal averaging. The choice of meteorological data and any changes in weather patterns between years will influence the model results. The variation in deposition budgets and relative contributions found for the models is only partly explained by the differences in spatial resolution, base year of emission and meteorological input; to a large extent, the discrepancies between the results derived from differences in model concept and formulation. The use of mixing layer averaged concentrations without appropriate correction factors might result in an underprediction of the dry deposition in or close to source areas. Overall, the four models studied, taken together, provide a coherent picture of deposition in The Netherlands and its origins in the SO₂, NO_x and NH₃ emissions throughout Europe. (Author's abstract) W90-04582

RECONSTRUCTION OF A CONCENTRATION FIELD IN A COASTAL SEA.

Institut Rudjer Boskovic, Zagreb (Yugoslavia). T. Legovic, N. Limic, and B. Sekulic. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 3, p. 217-231, September 1989. 5 fig, 2 tab, 16 ref.

Descriptors: *Path of pollutants, *Coastal waters, *Bays, *Turbulent flow, *Phosphorus, *Cycling nutrients, *Eddy diffusion, Eddies, Seasonal variation, Adriatic Sea.

Based on measurements of currents and concentrations of a chemical species (nutrient, pollutant), two control problems are solved in order to esti-

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mate turbulent dispersion coefficient, extinction coefficient and background concentration. Furthermore, a concentration field is reconstructed in a coastal sea. The two problems are analyzed for the Rijeka Bay on the northeastern coast of the Adriatic Sea. The parameters are estimated for summer and winter seasons. During summer, the mean horizontal turbulent dispersion coefficient is 14,500 sq cm/s and the background concentration of total phosphorus is 0.11 micromol P/L. For winter period, the estimation gave 11,000 sq cm/s and 0.2 micromol P/L, respectively. The turbulent dispersion coefficient estimated by the models used for this study agreed well with earlier measurements, for coastal seas of the same dimensions. The principal stability condition to be satisfied concerning the number and the distribution of measuring stations is their ability to represent concentration spreadings caused by the largest eddies in the basin; only then will the value of the turbulent dispersion coefficient remain very stable with respect to adding measurement stations while keeping their distribution uniform. Determination of the extinction coefficient is a stable numerical process with respect to the variation of the number of stations far from inflow sites. Small values of inflow and extinction coefficient may solve the problem as well as large ones. For prediction of background concentration, the number of data should have a uniform density if it is assumed that all the data have the same significance. (Friedmann-PTT) W90-04592

INFLUENCE OF RIMING ON THE CHEMICAL COMPOSITION OF SNOW IN WINTER OROGRAPHIC STORMS.

Nevada Univ. System, Reno. Atmospheric Sciences Center.
For primary bibliographic entry see Field 2C.
W90-04608

MODELING THE TRANSPORT OF CHROMIUM (VI) IN SOIL COLUMNS.

Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
H. M. Selim, M. C. Amacher, and I. K. Iskandar.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 996-1004, July/August 1989. 9 fig, 4 tab, 37 ref.

Descriptors: *Soil contamination, *Chromium, *Heavy metals, *Path of pollutants, *Model studies, Soil columns, Soil physical properties, Soil horizons, Leaching, Sorption, Acidic soils, Soil types.

Miscible displacement experiments were conducted to describe chromium Cr(VI) mobility and interactions in six different soils. For Calciorthid, Webster, and Norwoods soils, Cr breakthrough curves (BTCs) indicated that the interactions with the soil matrix were similar to those for a nonreactive solute where no or small retardation of the equilibrium type was observed. These observations are in support of earlier kinetic batch results where little retention was observed for a wide range of Cr concentrations in these (high pH) soils. The BTCs from Olivier, Cecil, and Windsor soils indicated high Cr retention capacity as indicated by increased retardation, low peak concentrations, irreversible sorption and extensive effluent tailing during desorption (leaching). A nonlinear retention/release model is proposed to describe Cr(VI) reactions during transport in soils. The model is incorporated into the convection-dispersion transport equation for reactive solute in uniform soils. The model was capable of providing a good description of the Cr BTCs for all soils where model parameters were obtained using a nonlinear least squares (best fit) parameter optimization scheme. The model grossly underestimated effluent concentrations for Olivier and Windsor BTCs when independently measured retention/release rate coefficients from the batch data sets were used. Model predictions overestimated the amount irreversibly retained by Cecil soil. Model predictions indicated that a unique set of independently measured rate coefficients was not capable of providing an adequate description of Cr BTCs for these soils. (Author's abstract)

W90-04615

IRON AND TRACE METALS IN SOME TIDAL MARSH SOILS OF THE CHESAPEAKE BAY.

Maryland Univ., College Park. Dept. of Agronomy.
T. M. Griffin, M. C. Rabenhorst, and D. S. Fanning.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1010-1019, July/August 1989. 5 fig, 4 tab, 41 ref.

Descriptors: *Chesapeake Bay, *Sediment contamination, *Trace elements, *Heavy metals, *Path of pollutants, *Iron, Zinc, Copper, Lead, Nickel, Cadmium, Adsorption, Soil contamination, Tidal marshes, Muck soils, Pollutant identification, Baltimore Harbor, Water pollution sources.

Sediments from six tidally influenced Chesapeake Bay marshes were sequentially extracted in order to determine their relative Fe, Zn, Cu, Pb, Ni and Cd content, and to ascertain the relative magnitude of the mechanisms (e.g. adsorption, sulfide occlusion, organic complexation etc) involved in their retention. The extraction sequence used, and the corresponding geochemical phases extracted were: 0.01 M DTPA (exchangeable, organic complexes); 0.1 M HCl (monosulfide occluded); dithionite citrate bicarbonate (CDB) (Feoxide occluded); H₂O₂ (disulfide occluded, organically bound complexes); HF-HNO₃-NCIO₄ (silicate mineral component). The sediments were dated using Pb210 geochronology in an effort to evaluate historical rates of metal deposition. Marshes in the vicinity of Baltimore, MD harbor were found to contain relatively higher metal concentrations than marshes in other areas of the bay thus indicating that the degree of metal contamination is related to the source distance. Rates of deposition were related to historical periods of industrial discharge and to the use of leaded fuels. Iron was retained in the marsh sediments mainly in the oxide and sulfide (FeS₂) phases and was apparently controlled by redox conditions. Copper, Cd and to a lesser extent Zn and Ni were apparently controlled by sulfide precipitation and pyrite coprecipitation thus rendering them noninfluential and unavailable to the marsh biota. Lead appears to be weakly complexed by organics and is a potential ecological threat since it is more readily available to plants and organisms and thus may accumulate in the food chain. (Author's abstract) W90-04617

ALUMINUM PRECIPITATION AND DISSOLUTION RATES IN SPODOSOL BS HORIZONS IN THE NORTHEASTERN USA.

Syracuse Univ., NY. Dept. of Civil Engineering.
R. A. Dahlgren, C. T. Driscoll, and D. C. McAvoy.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1045-1052, July/August 1989. 4 fig, 5 tab, 38 ref.

Descriptors: *Acid rain effects, *Kinetics, *Path of pollutants, *Aluminum, *Soil contamination, Soil horizons, Soil saturation, Podzols, Soil columns.

The kinetics of Al precipitation/dissolution reactions in Spodosol BS horizons from sites at Hubbard Brook Experimental Forest, NH and Bear Brook watershed, ME, were examined. A mechanical vacuum extractor was employed to draw solutions through soil columns at solution/soil residence times between 0.3 and 100 h. Equilibrium was approached from conditions of both undersaturation and oversaturation to determine if a particular soil mineral controlled Al(3+) activity. Column leachates were analyzed for major solutes followed by chemical speciations and calculation of mineral saturation indices. Results showed that apparent equilibrium with respect to Al(OH)₃ solubility was readily obtained from both conditions of undersaturation and oversaturation within 0.3 h. Computed saturation indices, for an Al(OH)₃ mineral with an equilibrium constant of 8.1 at 25°C were identical at all examined residence times. Aquo Al(Al₃+) within soil solutions may be regulated by the hydroxy-Al interlayer of expandable 2:1 layer silicates. Soil solutions from Bear Brook

also reached apparent equilibrium with imogolite at residence times in excess of 10 h. The laboratory results compared favorably with saturation indices calculated from stream and soil solutions at these sites. (Author's abstract) W90-04618

SOLUBILITY AND PHOSPHORUS-31 MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE OF PHOSPHORUS IN SLUDGE-AMENDED SOILS.

Florida Univ., Gainesville. Dept. of Soil Science.
Z. R. Hinedi, and A. C. Chang.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1057-1061, July/August 1989. 3 fig, 2 tab, 27 ref. NSF Grant CHE-84-40137.

Descriptors: *Phosphorus, *Sludge disposal, *Soil amendments, *Nuclear magnetic resonance, *Soil chemistry, *Path of pollutants, Carbonates, Solubility.

The solubility of phosphorus in two sludge-amended soils was studied. Solubility and activity ratio diagrams for P in sludge-amended soils were constructed and were compared with those of selected Ca-P, Fe-P, and Al-P minerals. The solid phase controlling P solubility in the sludge-amended soils appeared to be a carbonated apatite formed through coprecipitation. The P31 magic angle spinning nuclear magnetic resonance (P31 MAS NMR) examinations confirmed that P in the sludge-amended soils was in the form of calcium phosphate. The resonant peak (at isotropic chemical shift of 3.1 ppm) is indicative of an apatitic calcium phosphate environment characterized by carbonate substitution. Additionally, pyrophosphate was detected by the presence of a peak isotropic chemical shift of minus 9 ppm. (See also W90-04619) (Author's abstract) W90-04620

CLASSIFYING SOILS FOR ACIDIC DEPOSITION AQUATIC EFFECTS: A SCHEME FOR THE NORTHEASTERN USA.

Corvallis Environmental Research Lab., OR.
J. J. Lee, D. A. Lammers, D. L. Stevens, K. W. Thornton, and K. A. Wheeler.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1153-1162, July/August 1989. 2 fig, 5 tab, 7 ref.

Descriptors: *Acid rain, *Acid rain effects, *Water pollution sources, *Soil chemistry, *Sampling, *Statistical methods, Soil types, Catchment areas, Watersheds, Air-earth interfaces, Stream pollution, Leaching, Percolation.

The Direct/Delayed Response Project (DDRP) is estimating the number of lakes and streams in three U.S. regions that might become acidic due to current or altered levels of acidic deposition, and the long-term time scales involved. Because of the influence of soils on aquatic chemistry, DDRP acquired data on soils that were mapped, sampled, and analyzed using consistent methods across the regions. In the northeastern USA, about 600 soils (mainly phases of soil series) were identified during mapping of 145 watersheds. Because statistically adequate sampling of every soil was impractical, the soils were grouped into 38 sampling classes. Each of these classes was sampled across several (usually eight) watersheds. The properties of soils on specific watersheds (or portions of watersheds) can be estimated from the regional means and variances of the sampling classes and the percent occurrence of sampling classes on each watershed. The development of the sampling classes for the northeastern USA, the definitions of the classes, and the characteristics of soils within the classes are described. The occurrence of the sampling classes on watersheds of lakes in three classes of acid neutralizing capacity was analyzed using ANOVA and the chi-square test of homogeneity. As a group Spodosols seem especially important. Mineralogy of parent material may also be important. The sampling classes were used as strata for designing the soil sampling scheme for the DDRP. Final evaluation of the utility of this scheme will

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come from the very extensive data analysis and modeling tasks of the DDRP. (Friedmann-PTT) W90-04622

ANTECEDENT RAINFALL AND TILLAGE EFFECTS UPON INFILTRATION.
Minnesota Univ., St. Paul. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-04624

GASTROINTESTINAL EFFECTS OF WATER REUSE FOR PUBLIC PARK IRRIGATION.
Houston Univ. at Clear Lake City, TX. Bureau of Research.
R. Durand, and G. Schwebach.
American Journal of Public Health AJHEAA, Vol. 79, No. 12, p 1659-1660, December 1989. 2 tab, 7 ref.

Descriptors: *Water pollution effects, *Parks, *Public lands, *Water reuse, *Irrigation water, *Wastewater irrigation, *Urban runoff, *Human diseases, Infection, Enteric bacteria, Gastrointestinal disease, Public health, Bioindicators, Coliforms, Fecal coliforms, Fecal streptococci.

To investigate the gastrointestinal effects of employing recycled water as an irrigation source for urban public parks, subjects active in parks irrigated with potable water, nonpotable water of wastewater origin, and nonpotable water of runoff origin were studied. The project was conducted from 1984 to 1987 in Colorado Springs, CO. The nonpotable water of wastewater origin was effluent that had been sand-anthracite filtered and chlorinated up to a level of 4-6 mg/L. The nonpotable water of runoff origin was untreated city runoff that was collected in a pond. Wet grass conditions during activity and elevated densities of common indicator bacteria, but not exposure to nonpotable irrigation water per se, were found associated with an increased rate of gastrointestinal illness. The results suggest that recycled water can be used for public park irrigation without undue health hazards provided that bacteria density levels are kept below 500, 500, and 3,000/100 ml for fecal coliforms, fecal streptococci, and total coliforms, respectively. (Sand-PTT) W90-04636

CHROMIUM BIOGEOCHEMICAL CYCLE IN ABU KIR BAY, EAST OF ALEXANDRIA, EGYPT.
Alexandria Univ. (Egypt). Dept. of Oceanography.
O. Aboul.
Estuarine, Coastal and Shelf Science ECSD3, Vol. 29, No. 4, p 327-340, October 1989. 6 fig, 6 tab, 17 ref. Aquatic Environmental Pollution Project, EGY/73/058, UNDP-UNESCO Alexandria University.

Descriptors: *Chromium, *Water pollution sources, *Path of pollutants, *Marine sediments, *Coastal waters, *Biochemistry, *Geochemical cycles, *Bioaccumulation, Aquatic plants, Aquatic animals, Abu Kir Bay, Egypt, Fate of pollutants, Crustaceans, Wastewater pollution, Wastewater outfall, Sediments.

Abu Kir Bay, east of Alexandria, is affected by two main point sources of pollution, namely Tabia Pumping Station and Lake Edku Outlet. Chromium was measured in the Bay effluents, sea water, marine organisms of different trophic levels, and sediments. Cr concentration and mass emission from Tabia Pumping Station (242 microgram/L and 436 kg/d) to the Bay are very high compared to those of Lake Edku Outlet (33 microgram/L and 116 kg/d). Average Cr concentrations in the Bay coastal waters 0.120 microgram/L, 0.775 microgram/L and 1.185 microgram/L, respectively, for Cr(III), Cr(VI), and particulate phase. The surface distribution of Cr in the coastal waters showed the impact of Tabia Pumping Station on the Bay. On the basis of sediment concentrations of Cr in Abu Kir Bay, two 'hot spots' of Cr were identified, the area around Tabia Pumping Station outfall (>300 microgram/g dw) and another one in the immediate vicinity of Lake Edku Outlet (>200 microgram/g dw). Cr concentrations (mi-

crogram/kg) in Abu Kir Bay organisms increased in the following order: mixed plankton (68) > *Sardina pilchardus* (80) > or = *Mugil capito* (82) > *Mullus barbatus* (111) > *Solea solea* (123) > *Penaeus kerathurus* (168) > *Donax trunculus* (209) > *Neptunus pelagicus* (369) > *Ulva* species (1867) > *Enteromorpha* species (3345). The sequence is consistent for organisms from both west and east Abu Kir Bay, regardless of the significantly low Cr concentrations of the east Bay. The study showed that algae and crabs play a critical role in the biological transport of Cr and can be considered the best accumulators of Cr. From the total amount of Cr flux to the Bay, 552 kg/d, flushing of the Bay to the open sea removes 262 kg/d, and sedimentation within the Bay is 242 kg/d. An input/output box model for Cr in Abu Kir Bay was constructed to help in understanding its biogeochemical cycle. (Author's abstract) W90-04644

ANALYTICAL SOLUTION OF A CONVECTION-DISPERSION MODEL WITH TIME-DEPENDENT TRANSPORT COEFFICIENTS.
Western Australia Univ., Nedlands. Centre for Water Research.
D. A. Barry, and G. Sposito.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2407-2416, December 1989. 1 fig, 50 ref, append. NSF grant ECE-8513726.

Descriptors: *Path of pollutants, *Model studies, *Porous media, *Solute transport, *Mathematical models, Convection, Dispersion.

Mathematical studies of solute transport in porous media have often utilized 'equivalent' models of the transport process to remove undesired variability in the transport coefficients at the space and time scales of direct interest. Both deterministic and stochastic approaches in this genre produce an 'effective' convection-dispersion equation with time-dependent coefficients. This type of equation in one spatial dimension is investigated mathematically. A closed-form solution of the solute transport equation is derived for a semi-infinite spatial domain with arbitrary initial and boundary flux conditions. The solution reduces to well-known results for special forms of the time-dependent coefficients. In general, however, a Volterra integral equation of the second kind must be solved to evaluate the analytical solution of the transport equation. A stable and convergent numerical scheme, utilizing a trapezoidal quadrature rule, is presented for the solution of the Volterra equation. The method of solution developed should be applicable to a broad variety of solute transport problems, including particularly those in heterogeneous porous media. (Author's abstract) W90-04658

SIMULATION OF THREE-DIMENSIONAL FLOW OF IMMISCIBLE FLUIDS WITHIN AND BELOW THE UNSATURATED ZONE.
GeoTrans, Inc., Herndon, VA.
C. R. Faust, J. H. Guswa, and J. W. Mercer.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2449-2464, December 1989. 10 fig, 8 tab, 61 ref.

Descriptors: *Hazardous wastes, *Groundwater pollution, *Groundwater movement, *Soil water, *Model studies, *Chemical wastes, *Landfills, *Path of pollutants, Mathematical models, Computer models, Nonaqueous phase liquids, Finite difference methods, Aeration zone, Fluid flow, New York.

A two-phase flow model is based on a three-dimensional, finite-difference formulation. As three-dimensional simulations can require substantial computer effort, a numerical technique takes advantage of vector and parallel processing computer architecture. The model is posed in terms of water saturation and nonwetting fluid pressure. It uses three-phase capillary pressure and relative permeability relationships to permit simulation within or below the unsaturated zone. A modified formulation of slice successive overrelaxation (an iterative matrix solution technique) is introduced. This technique is designed to use parallel process-

ing capabilities of new computers. The model is applied to immiscible fluid flow at two chemical waste landfills near Niagara Falls, N.Y. At both sites, denser than water, nonaqueous liquids (NAPLs) are present in the groundwater regimes in relatively large quantities. The model applications address several technical concerns at the two sites, including the effectiveness of clay as a geologic barrier to NAPL migration owing to capillary pressure forces, the three-dimensional aspects of dense NAPL flow, and the sensitivity of NAPL recovery in pumping wells due to various hydrogeologic and fluid properties. The results show that (1) even under a downward hydraulic gradient, natural differences in capillary pressure relationships for different lithologies can prevent downward migration of NAPL, (2) without any lithologic-capillary barrier, an upward hydraulic gradient induced by a dewatering system can prevent downward migration of NAPL, (3) NAPL recovery at wells is sensitive to relative permeability, a relationship that requires field calibration in many settings, and (4) the three-dimensional aspects of two-phase flow and hydrogeologic heterogeneity require explicit treatment in many settings. (Author's abstract) W90-04662

STOCHASTIC ANALYSIS OF THE INFLUENCE OF SOIL AND CLIMATIC VARIABILITY ON THE ESTIMATE OF PESTICIDE GROUNDWATER POLLUTION POTENTIAL.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
W. A. Jury, and J. Gruber.
Water Resources Research WRERAQ, Vol. 25, No. 12, p 2465-2474, December 1989. 9 fig, 5 tab, 21 ref.

Descriptors: *Path of pollutants, *Model studies, *Groundwater pollution, *Pesticides, *Solute transport, *Leaching, *Path of pollutants, Stochastic models, Mathematical models, Monte Carlo method, Climates.

Soil and climatic variability contribute in an unknown manner to the leaching of pesticide residues below the surface soil zone where degradation occurs at maximum levels. The climatic variability model of Eagleson is coupled to the soil variability transport model of Jury to produce a probability density distribution of residual mass fraction (RMF) remaining after leaching below the surface degradation zone. Estimates of the RMF distribution are shown to be much more sensitive to soil variability than climatic variability, except when the residence time of the chemical is shorter than one year. When soil variability dominates climatic variability, the applied water distribution may be replaced by a constant average water application rate without serious error. Simulations of leaching are run with 10 pesticides in two climates and in two representative soil types with a range of soil variability. Variability in soil or climate act to produce a nonnegligible probability of survival of a small value of residual mass even for relatively immobile compounds which are predicted to degrade completely by a simple model which neglects variability. However, the simpler model may still be useful for screening pesticides for groundwater pollution potential if somewhat larger residual masses of a given compound are tolerated. Monte Carlo simulations of the RMF distribution agreed well with model predictions over a wide range of pesticide properties. (Author's abstract) W90-04663

FIELD-SCALE TRANSPORT OF INTERACTING SOLUTES THROUGH THE UNSATURATED ZONE: 1. ANALYSIS OF THE SPATIAL VARIABILITY OF THE TRANSPORT PROPERTIES.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics.
For primary bibliographic entry see Field 2G.
W90-04664

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

FIELD-SCALE TRANSPORT OF INTERACTING SOLUTES THROUGH THE UNSATURATED ZONE: 2. ANALYSIS OF THE SPATIAL VARIABILITY OF THE FIELD RESPONSE.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
For primary bibliographic entry see Field 2G.
W90-04665

HYDROSTRATIGRAPHIC INTERPRETATION USING INDICATOR GEOSTATISTICS.
California Univ., Santa Cruz. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-04667

EFFECT OF SEDIMENT ON CADMIUM AND LEAD IN THE STONE LOACH (NOEMACHEILUS BARBATULUS L.).
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
For primary bibliographic entry see Field 5C.
W90-04673

BIOACCUMULATION AND HISTOCHEMICAL LOCALIZATION OF CADMIUM IN DREISSENA POLYMORPHA EXPOSED TO CADMIUM CHLORIDE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
For primary bibliographic entry see Field 5C.
W90-04674

CADMIUM AND LEAD ACCUMULATION BY GOLDFISH EXPOSED TO AQUEOUS REFUSE INCINERATOR FLY ASH LEACHATE.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Toxic Chemicals Lab.
C. A. Bache, and D. J. Lisk.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 846-849, December 1989. 2 tab, 17 ref.

Descriptors: *Path of pollutants, *Fish physiology, *Bioassay, *Carp, *Cadmium, *Fly ash, *Lead, *Bioaccumulation, Leachates, Water pollution effects, Toxicity.

The accumulation and effects of lead and cadmium leachates of fly ash obtained from a municipal refuse incinerator on goldfish (*Carassius auratus*) was examined by placing the ash in a cellulose extraction thimble in the filter of the aquaria where the fish were held for 12 days. A filter containing a cellulose thimble without fly ash was fitted to the aquaria containing the control fish. At the end of the test period, fish were analyzed for cadmium and lead and examined histologically. The cadmium and lead content of ash-exposed fish were significantly higher than that in the control fish. Mild necrosis of the margins of all fins except the adipose fin was grossly evident in all fish exposed to fly ash leachate. Histologic examination of fish tissues revealed no abnormalities except for mild localized necrosis of epithelium on the margins of fins of ash-exposed fish. The ash-exposed fish contained 3.75 ppm Cd and 1.55 ppm Pb compared to 0.28 ppm Cd and 0.33 ppm Pb in control fish. (Geiger-PTT)
W90-04678

DISTRIBUTION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH'S) IN MARSH SEDIMENTS, IRAQ.
Basrah Univ. (Iraq). Dept. of Environmental Marine Chemistry.
H. T. Al-Saad, and A. A. Al-Timari.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 864-869, December 1989. 1 fig, 1 tab, 12 ref.

Descriptors: *Hydrocarbons, *Fate of pollutants, *Marshes, *Sediments, *Path of pollutants, *Hydrocarbons, *Iraq, *Water pollution sources, Spatial distribution, Oil pollution, Biodegradation, Microbial degradation, Oxidation, Marsh plants, Organic matter, Particulate matter, Aromatic compounds.

Sediment samples collected from seven stations in Hor al-Hammar marsh in Iraq were analyzed for polycyclic aromatic hydrocarbons (PAH) by gas chromatography. In surface sediments, PAH contents were found to vary between 0.59 ppb at station 5 to 2.07 ppb dry weight sediment at station 4. PAH levels in subsurface sediments varied between 0.46 ppb at station 5 to 1.42 ppb dry weight at station 4. The highest PAH levels were found at station 4; these higher PAH levels may be due to numerous boats mooring in the area which spill small amounts of fuel oil containing acetophenone and naphthalene into the water. Also, the marsh sediments at station 4 receive waters from both the Tigris and Euphrates Rivers which carry large amounts of particulate matter to which organic matter from anthropogenic sources may be sorbed. Some evidence indicates that the surrounding aquatic plants may contribute some PAH's to the marsh sediments. The low levels of PAH's in the marsh sediments examined may be due to processes of bacterial degradation and photooxidation that remove these compounds from the environment. (Geiger-PTT)
W90-04681

PERSISTENCE AND DISTRIBUTION OF PCB'S IN THE SEDIMENTS OF A RESERVOIR (LAKE HARTWELL, SOUTH CAROLINA).
Oak Ridge National Lab., TN. Environmental Sciences Div.
F. M. Dunnivant, A. L. Polansky, and A. W. Elzerman.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 870-878, December 1989. 3 fig, 1 tab, 18 ref. NSF Grant ISP-8011451.

Descriptors: *Polychlorinated biphenyls, *Lake sediments, *Sediment contamination, *Path of pollutants, *Water pollution sources, Organic wastes, South Carolina, Spatial distribution, Reservoirs, Landfills.

Levels of polychlorinated biphenyls (PCBs) were determined in sediment core samples taken at eleven sites in Lake Hartwell, a PCB contaminated reservoir in South Carolina and from two sites in the Seneca River which flow into the lake. The core samples were separated in 4-5 cm segments which, after cleanup and extraction, were each analyzed quantitatively for PCB content by gas chromatography. PCB levels in sediments from the Seneca River contained high concentrations of PCBs. Possible PCB sources to the Seneca River are abandoned landfills adjacent to the river, known to contain waste drums and capacitors. In lake sediments, PCB concentrations generally decreased with increasing distance downstream with the highest concentration, 88.5 micrograms/gm, occurring at a depth of approximately 27.5 cm in the sediment. A sampling station located in a small cove, offset from the main channel, did not fit this pattern of decreasing PCB concentrations with distance from the point source suggesting that pollutant concentration is influenced by physical features of the lake such as sediment mixing or tributary inputs and local distribution patterns. (Geiger-PTT)
W90-04682

WATER HYACINTH AS INDICATOR OF HEAVY METAL POLLUTION IN THE TROPICS.
Institute of Transport Investigations, Havana (Cuba).
For primary bibliographic entry see Field 5A.
W90-04684

DINOSEB PRESENCE IN AGRICULTURAL SUBSURFACE DRAINAGE FROM POTATO FIELDS IN NORTHWESTERN NEW BRUNSWICK, CANADA.
Inland Waters Directorate, Moncton (New Brunswick). Water Quality Branch.
H. J. O'Neill, T. L. Pollock, H. S. Bailey, P. Millburn, and C. Gartley.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 935-940, December 1989. 3 fig, 7 ref.

Descriptors: *Dinoseb, *Agricultural runoff, *Path of pollutants, *Herbicides, *Pesticide residues, Potatoes, Desiccants, Soil contamination, Canada, Gas chromatography.

Agricultural drainage from the tile drains of five New Brunswick potato fields were analyzed for dinoseb content by capillary column gas chromatography from April 1987 to May 1988. Three sites of drainage had application histories indicating the use of dinoseb (as Dytap 300) during the 1986 growing season. Dinoseb had been used as a pre-emergent herbicide in the spring of 1986 at one site and as a desiccant at the other two sites in the early fall of 1986. Carryover of dinoseb residues was evident when the pesticide was not applied in a given growing season. Dissimilar concentrations of dinoseb at different drains was attributed to different application rates of the pesticide and dilution by ground water. Dinoseb concentrations in water collected from the tile outlets was an indication of the amount of dinoseb intercepted by the tiles and confirmed that dinoseb had migrated through 1 m of soil. On nineteen occasions, the concentration of dinoseb emanating from the tiles was in excess of the proposed maximum acceptable toxic concentration of 0.5 micrograms/liter. Residual carryovers of dinoseb were found in agricultural runoff up to 23 months after application. Where dinoseb had been applied 42 months prior to drainage sampling, no measurable dinoseb concentrations were noted in tile drainage. On soils typical to this part of New Brunswick, a soil persistence of 24 to 42 months is implied. (Geiger-PTT)
W90-04685

ENVIRONMENTAL DYNAMICS OF THE CARBAMATE INSECTICIDE ALDICARB IN SOIL AND WATER.
Dunn Geoscience Corp., Albany, NY.
F. L. Mink, J. F. Risher, and J. F. Stara.
Environmental Pollution ENPOEK, Vol. 61, No. 2, p 127-155, 1989. 7 tab, 45 ref.

Descriptors: *Aldicarb, *Pesticide residues, *Path of pollutants, *Fate of pollutants, *Insecticides, *Degradation, *Biodegradation, *Soil contamination, Drinking water, Microbial degradation, Water pollution effects, Soil bacteria, Carbamate pesticides, Hydrolysis, Absorption, Groundwater pollution, Leaching.

Aldicarb is a soil-applied systemic pesticide that the US EPA is now considering banning in the United States. Aldicarb is fairly rapidly oxidized to the sulfoxide, with a half-life of about 7 days in some soils, and much more slowly to the sulfone (pH-dependent with half-lives varying from a few minutes at a pH of > 12 to approximately 560 days at a pH of 6.0). Persistence, carry-over, and translocation vary with soil and environmental conditions. Drainage aquifers and drinking water wells are known to be susceptible to contamination; levels of approximately 550 ppb have been recorded. Leaching of aldicarb through soils depends on soil type and texture. Soil moisture content, organic content, time and temperature, and soil type and texture all affect degradation of aldicarb in soils. Irrigation causes more rapid degradation of aldicarb, but is responsible for little, if any lateral movement of aldicarb through the soil. Aldicarb inhibits nitrifying and microbial degradation processes in some soil bacteria. At levels needed for pest control, aldicarb was not expected to harm soil microorganisms and was rapidly degraded by some soil microorganisms. The rate of hydrolysis of aldicarb in water depends upon pH. At pHs of 6.7, and 8, aldicarb hydrolyzed slowly, while the rate of hydrolysis increased at both higher and lower pH levels. Foods are known to take up the pesticide; aldicarb levels of 600 ppb have been found in potatoes. (Geiger-PTT)
W90-04686

PHOTODECOMPOSITION OF METALAXYL IN AN AQUEOUS SOLUTION.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
J. R. Yao, S. Y. Liu, L. J. Freyer, R. D. Minard, and J. M. Bollag.

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Journal of Agricultural and Food Chemistry JAFCAU, Vol. 37, No. 6, p 1518-1523, November 1989. 4 fig, 2 tab, 9 ref.

Descriptors: *Photolysis, *Fungicides, *Irradiation, *Fate of pollutants, Pollutant identification, Ultraviolet radiation, Spectroscopy, Metalaxyl.

Ultraviolet irradiation of metalaxyl in aqueous solution resulted in 70% substrate transformation in 5 days, with rates of transformation affected by irradiation time, pH, and substrate concentration. Addition of 1% acetone accelerated photodecomposition, while riboflavin and methylene blue had no effect. After 5 days of irradiation of metalaxyl at pH 6.8, two products (A and B) were formed: product A contained 3% and B 6% of the initial radioactivity. The two compounds were isolated by thin layer chromatography and their structures identified by mass and nuclear magnetic resonance spectroscopy. Irradiation of A resulted in the formation of B. In each case photolysis caused a rearrangement of the N-acyl group to the 4-position on the aromatic ring. (Author's abstract) W90-04687

USE OF MIXED-FUNCTION OXYGENASES TO MONITOR CONTAMINANT EXPOSURE IN WILDLIFE

Patuxent Wildlife Research Center, Laurel, MD. For primary bibliographic entry see Field 5A. W90-04689

MICROBIAL DEGRADATION OF NITROGEN, OXYGEN AND SULFUR HETEROCYCLIC COMPOUNDS UNDER ANAEROBIC CONDITIONS: STUDIES WITH AQUIFER SAMPLES.

Oklahoma Univ., Norman. Dept. of Botany and Microbiology. E. P. Kuhn, and J. M. Sufita. Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1149-1158, 1989. 1 fig, 3 tab, 63 ref. U.S. EPA Assistance Agreements No. CR-812808 and CR-813559.

Descriptors: *Biodegradation, *Microbial degradation, *Fate of pollutants, *Anaerobic conditions, *Groundwater pollution, Biodegradation, Organic compounds, Pesticides, Aquifers, Aromatic compounds.

The potential for anaerobic biodegradation of 12 heterocyclic model compounds was studied. Nine of the model compounds were biotransformed in aquifer slurries under sulfate-reducing or methanogenic conditions. The nitrogen and oxygen heterocyclic compounds were more susceptible to anaerobic biodegradation than those compounds containing a sulfur heteroatom. Carboxy-substituted compounds were anaerobically metabolized more readily than unsubstituted or methylated analogues. In methanogenic incubations, 47 to 84% of the expected amount of carbon in pyridine, 4-picoline, nicotinic acid and 2-thiophene carboxylic acid was recovered as methane. In contrast, only small amounts of methane were detected in aquifer slurries amended with compounds containing an oxygen heteroatom, even though a decrease in the parent substrate concentration occurred. Pyridine, 2-picoline and 4-picoline were biotransformed within three months under sulfate-reducing conditions. However, longer incubation times were required for the degradation of these substrates in methanogenic aquifer slurries. (Author's abstract) W90-04692

AQUEOUS CHLORINATION OF RESORCINOL

Point Loma Nazarene Coll., San Diego, CA. Dept. of Chemistry. For primary bibliographic entry see Field 5F. W90-04693

ENVIRONMENTAL PERSISTENCE AND FATE OF FENOXAPROP-ETHYL

California Univ., Davis. Dept. of Environmental Toxicology. A. P. Toole, and D. G. Crosby. Environmental Toxicology and Chemistry

ETODCK, Vol. 8, No. 12, p 1171-1176, 1989. 4 fig, 1 tab, 7 ref. USDA Regional Research Project W-45. NIEHS Training Grant ES-07059.

Descriptors: *Herbicides, *Fate of pollutants, *Herbicides, *Pesticide residues, *Photolysis, Rice, Soil contamination, Degradation, Adsorption, Hydrolysis.

The environmental persistence and fate of ethyl 2-(4-(6-chloro-2-benzoxazolyl) oxyphenoxyl) propanoate (fenoxaprop-ethyl), a herbicide proposed for selective control of grasses in California rice, have been investigated under laboratory and field conditions. In the field, it dissipated rapidly from both water and soil, with half-lives in water < 4 hr and soil residues below detectability within 6 days. The photolysis half-life in sterile, distilled water was 269 +/- 19 hr; in field water a combination of microbial and photochemical reactions resulted in a half-life of 29 +/- 2 hr. Products included the corresponding acid, 6-chlorobenzoxazolinone, ethyl 2-(4-hydroxyphenoxyl) propanoate and 2-(4-hydroxyphenoxyl) propanoic acid. Hydrolysis was slow at pH 6.1 and 7.4 but resulted in a half-life of only 8.3 hr at pH 9.1. Fenoxaprop-ethyl is essentially nonvolatile (Henry's Law constant = .000007) and was bound moderately to soil (Koc = 6800). These properties represent a near optimum for pesticide persistence. (Author's abstract) W90-04694

TOXICOLOGY STUDIES OF A CHEMICAL MIXTURE OF 25 GROUNDWATER CONTAMINANTS: I. CHEMISTRY DEVELOPMENT.

National Toxicology Program, Research Triangle Park, NC. R. S. H. Yang, T. J. Goehl, R. D. Brown, A. T. Chatham, and D. W. Arneson. Fundamental and Applied Toxicology FAATDF, Vol. 13, No. 3, p 366-378, October 1989. 4 tab, 18 ref.

Descriptors: *Toxicity, *Path of pollutants, *Bioassay, *Groundwater pollution, *Toxicology, *Organic compounds, Industrial wastes, Hazardous wastes, Phenols, Organic wastes, Metals.

An aqueous mixture of 25 groundwater contaminants was formulated based upon EPA survey concentrations of these chemicals in the groundwater around hazardous waste disposal sites, their toxicity information, and their solubility in this unique matrix. Analytical methods have been developed for all 25 chemicals in the drinking water mixture. Because the anticipated animal studies were to be conducted at various laboratories, for ease of handling and maximum stability, the stock solution was stored or shipped as two substock solutions: an organic substock with 18 neat organic chemicals in a glass vial sealed with minimum headspace and an aqueous substock solution with 6 metals of various salt forms and phenol. The concentrations of the solutions were such that direct mixing of the organic and aqueous substocks produced the desired high dose level for the animal experiments. Although some losses of certain organic chemicals were inevitable, the stability of this mixture at different concentrations under simulated animal experimental conditions and under storage was such that it is possible to conduct animal experiments using the mixture in drinking water. In addition, reasonable estimates of the intake of individual chemicals may be achieved provided that fresh dosing solutions are prepared at 48-hr to 72-hr intervals and that comprehensive analyses are carried out. (Geiger-PTT) W90-04697

CONCENTRATIONS OF CHLORINATED PESTICIDES AND PCBs IN MICROLAYER AND SEAWATER SAMPLES COLLECTED IN OPEN-OCEAN WATERS OFF THE U.S. EAST COAST AND IN THE GULF OF MEXICO.

Little (Arthur D.), Inc., Cambridge, MA. Marine Sciences Unit. T. C. Sauer, G. S. Surell, J. S. Brown, D. Redford, and P. D. Boehm. Marine Chemistry MRCHBD, Vol. 27, No. 3-4, p 235-257, October 1989. 3 fig, 8 tab, 22 ref. U.S. EPA Contract 68-03-3319.

Descriptors: *Water pollution, *Fate of pollutants, *Pesticides, *Chlorinated hydrocarbons, *Pesticide residues, *Seawater, *Polychlorinated biphenyls, Pollutant identification, Lindane, DDT, Chlordane, Surface water, Gas chromatography, Gulf of Mexico, Atlantic Ocean.

Microlayer and surface seawater samples, collected during four surveys in 1985 and 1987 from open-ocean waters off the United States middle and south East Coast and in the Gulf of Mexico, were analyzed for selected chlorinated pesticides and polychlorinated biphenyls (PCBs). Analyses detected by gas chromatography-electron capture detection were confirmed by analysis with a different gas chromatographic column or detector or both. Of the 27 filter and filtrate microlayer samples collected during the surveys, only one contained pesticides or individual PCB congeners above method detection limits ranging from 0.1 to 1.0 nanograms/liter. Most PCB congeners and pesticides were not detected in any of the 24 open-ocean surface seawater samples, even at method detection limits of 0.5-3.0 picograms/liter, which were achieved by processing 900 liters of seawater. Lindane was detected at concentrations in the range of 0.01-0.15 nanograms/liter in nearly every seawater filtrate sample taken off the Southeast Coast and in the Gulf of Mexico. Chlordane was the other pesticide found predominantly in Gulf of Mexico samples at concentrations of 0.004-0.034 nanograms/liter. Only a few samples contained very low concentrations of DDTs and their degradation products. No more than four to five individual PCB congeners were detected in any seawater sample; none of the samples possessed an Aroclor pattern. Concentrations of PCBs and DDT identified in earlier studies were significantly higher than their concentrations in samples collected in the present surveys. These observations may reflect an actual decline in PCB and DDT levels in the open ocean or improvement in analytical methods, including confirmation of analyte identities. (Author's abstract) W90-04700

SIMPLE AND PRACTICAL MODEL FOR TOXICOLOGICAL ASSESSMENT OF NITRIFICATION BYPRODUCTS IN RIVERS.

Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigación y Tecnología.

J. V. Tarazona, and M. J. Munoz. Toxicological and Environmental Chemistry TXECBF, Vol. 24, No. 1-2, p 9-15, 1989. 5 fig, 1 tab, 14 ref.

Descriptors: *Toxicology, *Water pollution sources, *Nonpoint pollution sources, *Toxicity, *Spain, *Nitrification, *Hydrologic models, Fate of pollutants, Rivers, Model studies, Nitrites, Nitrates, Ammonia, Wastewater disposal.

A simple and practical model for the toxicological on-field assessment of the nitrification process in rivers was developed from the published raw data for the physical-chemical characteristics of Spanish rivers. Ammonia, nitrites and nitrates concentrations were plotted versus the distance between sampling stations, then the waste discharge points were also plotted and nitrogen evolution was studied. Three field studies were performed to check the model; one a large time-and space scale study for 3 yr along 400 km of the Tago river, the other two single-source studies, where nitrification by-products were analyzed downstream of a point pollution source (an industrial organic nitrogen-rich ammonia-free sewage and a trout fish farm effluent rich in both organic nitrogen and ammonia). The most important aspects from the toxicological point of view (i.e., the highest ammonia and nitrite concentrations and their location downstream) could be easily assessed considering a model with the following characteristics: a linear increase and decrease of ammonia concentrations, a linear increase of nitrate concentration beginning just at the beginning of ammonia decrease, similar absolute values for the slopes of ammonia decrease and nitrate increase lines, and linear increase and decrease of nitrite concentration with the maximal value just at the end of ammonia decrease. When

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there is more than one pollution source, the global evolution is obtained by simple addition of evolution lines. Field studies made in the Tajo river show that in a large-scale study, the model is able to find the contribution of different pollution sources. In the second study, the model demonstrated that a high nitrite concentration, higher than the LC50 96 hr for salmonid fish, observed in the water input channel of a trout fish farm, was generated by an industrial effluent located 2 kilometers upstream. (Geiger-PTT)
W90-04702

CONTRIBUTION OF DOMESTIC WATER USE TO INDOOR AIR CONCENTRATIONS OF CHLOROFORM IN NEW YORK CITY APARTMENTS - A PILOT STUDY.

Columbia Univ., New York. School of Public Health.

A. H. Stern, and L. R. Andrews.

Toxicological and Environmental Chemistry TXECBP, Vol. 24, No. 1-2, 1989. 3 tab, 31 ref.

Descriptors: *Air pollution sources, *Path of pollutants, *Drinking water, *Chloroform, *Air pollution, Volatility, Domestic use, Organic compounds, Pollutant identification, Gas chromatography.

Indoor air exposure to volatile organic water contaminants volatilized from domestic water use has been hypothesized to be a significant source of exposure to these substances. Such releases have been demonstrated in laboratory and field settings. However, this phenomenon has not previously been measured under actual exposure conditions with water contamination levels otherwise acceptable for domestic use. The contribution of domestic water use to indoor air levels of chloroform was measured under the assumption that chloroform concentrations in occupied and unoccupied apartments would differ significantly only as a result of water use. Chloroform concentrations in occupied and unoccupied indoor air were compared over approximately one week in ten New York City apartments. Subjects wore passive diffusion sampling badges during all periods at home and separate sampling badges were used during unoccupied periods for chloroform collection in frequently occupied areas. Occupancy and water use logs were kept and aqueous chloroform levels were measured at each location. Time-weighted occupied and unoccupied chloroform levels were found to be between 131 and 2927 nanograms/cu m. Comparison of occupied and unoccupied levels indicated that a hypothesis of no significant difference could not be rejected ($p > 0.457$). Occupied and unoccupied values were highly correlated, suggesting a common background source of chloroform. No significant correlation was seen between these values and either water or shower use, or aqueous chloroform levels. (Author's abstract)
W90-04704

STUDY OF HUMIC ORGANIC SUBSTANCES AND HEAVY METALS IN THE IVANKOVO RESERVOIR WATERS.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.

A. Kocharian, A. Malutin, I. Lapin, E. Tchudinov, and G. Varvanina.

Toxicological and Environmental Chemistry TXECBP, Vol. 24, No. 1-2, p 83-93, 1989. 4 fig, 3 tab, 19 ref.

Descriptors: *Humic acids, *Fulvic acids, *Reservoirs, *Heavy metals, *Color, *Path of pollutants, Colloids, Organic matter, Dissolved solids, Conductivity, Spectral analysis.

Correlations between color values and humic and fulvic acids content in waters as well as the influence of colloid and dissolved forms of humic substances on heavy metal migration are studied in the Ivankovo Reservoir. Humic acid/fulvic acid ratios varied from season to season with ratios of 0.40 for summer and autumn periods, 0.12 in winter, and 0.14-0.16 in spring. Color values rose in the summer dry period due to the increase of total content of organic substances in the water. Empirical correlations between color values and humic

acid content were obtained for different phases of the hydrological regime. These relationships led to the conclusion that fulvic and humic acid concentrations were dependent on the electrical conductivity of the reservoir water. Examination of the electrical conductivity of the water allowed estimations of the humic and fulvic acid sedimentation in the reservoir and prediction of their role in changing water color. A scheme of analysis of heavy metals in the reservoir waters showed the occurrence of heavy metals in ten fractions. Concentrations of heavy metals in fractions was determined with the help of atom emission spectrometry with inductively coupled plasma. Complexes with organic ligands and associations with organic-mineral colloids were most typical for the solutions of Cu, Mo, Co, Cd, and Zn. Coefficients of correlation between the content of organic and mineral components in the water were calculated, which were useful in determining the reservoir capacity for self-purification from humic substances by means of their sedimentation and accumulation in bottom sediments. (Geiger-PPT)
W90-04705

LAKE VATTEN, SWEDEN: A 20-YEAR PERSPECTIVE

National Swedish Environment Protection Board, Uppsala (Sweden). Environmental Quality Lab.

For primary bibliographic entry see Field 2H.

W90-04709

FLOW AND DISTRIBUTION OF CHROMIUM IN THE SWEDISH ENVIRONMENT: A NEW APPROACH TO STUDYING ENVIRONMENTAL POLLUTION.

Lund Univ. (Sweden). Dept. of Social and Economic Geography.

S. Anderberg, B. Bergback, and U. Lohm.

AMBIO AMBOCX, Vol. 18, No. 4, p 216-220, 1989. 6 fig, 1 tab, 20 ref.

Descriptors: *Path of pollutants, *Pollution load, *Chromium, *Sweden, Industrial wastes, Model studies, Bioaccumulation, Air pollution.

Point source emission from industrial production processes has been the major focus of environmental concern in the past. In this article it is argued that the accumulating amount of goods/products in society should also be focused on in the future. From these goods substances will sooner or later be leached out to the environment. A case study using chromium in Sweden is presented in this paper as one example of a substance that may accumulate in the environment. Total flows of chromium for the 20th century, based on trade statistics, production of goods and persistence of products in the environment are estimated. It was found that yearly consumption emissions are higher than the production emissions, i.e. point source emissions from different industries. Ferrous alloy, steel industries, and leather tanneries probably account for more than 90% of the emissions to water and almost all emissions to air. Emissions to water have primarily taken place in Bergslagen and around tanning factories in southern Sweden, whereas the large ferrous alloy plants near Lake Vanern in western Sweden and some important concentrations in Bergslagen dominate the air-emission picture. Interesting pathways to further development would be to try to model the ways in which chromium is emitted, transported, and finally accumulated in different sinks such as soils and sediments. It is also essential to expand our knowledge on how chromium can be mobilized from different products, and to improve ways of weighing together emissions to obtain a picture of the emerging emission landscape. It is probably also necessary to reduce the scale and study the fate of emitted chromium within a suitable watershed. Using this method, it would be interesting to compare the results, in an appropriate form, with the results of an environmental archive study like those of sediments and shells of mussels. (Shidler-PTT)
W90-04710

PATHWAYS OF ARSENIC UPTAKE AND INCORPORATION IN ESTUARINE PHYTO-

PLANKTON AND THE FILTER-FEEDING INVERTEBRATES EURYTOMORA AFFINIS, BALANUS IMPROVIVUS AND CRASSOSTREA VIRGINICA.

Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab. J. G. Sanders, R. W. Osman, and G. F. Reidel.

Marine Biology MBIOAJ, Vol. 103, No. 3, p 319-325, 1989. 6 fig, 40 ref.

Descriptors: *Path of pollutants, *Arsenic, *Estuarine environment, *Macroinvertebrates, Phytoplankton, Crustaceans, Oysters, Chesapeake Bay.

Arsenic uptake from water and from phytoplankton was followed in the copepod *Eurytomora affinis* and the barnacle *Balanus improvivus* collected from the Patuxent River estuary, Chesapeake Bay, in 1987, and in the oyster *Crassostrea virginica* obtained from a hatchery on the shore of Chesapeake Bay in 1987. Dissolved arsenic was readily taken up by phytoplankton and by shell material of *B. improvivus* and *C. virginica*; however, no dissolved arsenic was incorporated into the invertebrate tissues. When *E. affinis*, *B. improvivus* and *C. virginica* were fed phytoplankton containing elevated arsenic contents, significant arsenic incorporation occurred. Juvenile *B. improvivus* incorporated relatively more arsenic than adults of all three species. Compared to the 100 to 200% increase in arsenic content by phytoplankton exposed to dissolved arsenic, the 25% to 50% increase in these invertebrate species via trophic transfer is relatively small. Even though the trophic pathway for arsenic transfer is the major one for higher trophic levels within an ecosystem, the potential for direct arsenic impact to trophic levels other than phytoplankton appears to be minimal. (Author's abstract)
W90-04727

SPRAT-A SIMPLE RIVER QUALITY IMPACT MODEL FOR INTERMITTENT DISCHARGES.

Water Research Centre, Swindon (England). Swindon Engineering Centre.

For primary bibliographic entry see Field 5C.

W90-04773

MODELLING OF POLLUTION LOADS FROM COMBINED SEWER SYSTEMS TO RECEIVING WATERS.

PH-Consult ApS, Gentofte (Denmark).

S. O. Petersen.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1797-1800, 1989. 3 fig, 4 ref.

Descriptors: *Urban hydrology, *Path of pollutants, *Statistical analysis, *Storm-overflow sewers, *Pollution load, *Model studies, *Combined sewer overflows, Sewers, Storm wastewater, SAMBA model.

The SAMBA model for predicting pollution transport in Danish urban storm drainage was demonstrated. To calculate the pollution load, the model uses as input a mean concentration of wastewater and a mean concentration of storm water which is then mixed and the pollution mass transport over the combined sewer overflow is determined. Different types of statistics, depending on the type of pollutant, are shown. The cumulative effect of pollutants such as nutrients is represented as yearly load. The acute effect of pollutants such as BOD is presented as extreme statistics. The use of mean concentrations of storm water and wastewater was adequate for calculation of yearly loads. In the calculation of extreme statistics, the stochastic variation of the storm water should be taken into account. (Cassar-PTT)
W90-04774

SELF-PURIFICATION PROCESSES ALONG A POLLUTED RIVER IN GREECE.

National Centre for Marine Research, Athens (Greece).

T. S. Koussouris, A. C. Diapoulis, I. T. Bertahas, and K. C. Grizalis.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1869-1872, 1989. 2 fig, 5 ref.

Sources Of Pollution—Group 5B

Descriptors: *Water pollution effects, *Nonpoint pollution sources, *Water pollution sources, *Fate of pollutants, *Rivers, *Self-purification, *Water treatment, Louros River, Greece, Agricultural runoff, Nitrification, Water quality, Nutrients, Wetlands, Aquatic life, Invertebrates, Dissolved oxygen, Water temperature, Phosphates, Nitrates, Ammonia, Seasonal variation, Wastewater pollution.

Pollution sources in the agricultural basin of the Louros River in Greece include fertilizers, pesticides, agricultural industry wastes, livestock, and domestic sewage (no treatment plants in the area). The river flood plain consists of wetlands and lagoons populated with reeds. Water quality parameters for May and October 1987 were reported for sampling stations from the mouth to 36.5 km upstream. Dissolved oxygen was 54 to 155%; temperature, 18°C; pH 6.5 to 8.3; total hardness, 210 to 450 mg/l; alkalinity, 150 to 200 mg/l CaCO₃; salt, 500 to 600 mg/l. Nitrates, phosphates, and ammonia had high concentrations in March, May and November. Nitrification was blocked over the last 5.3 km of river for most of the year; in summer these conditions extended to 18.5 km. Rates of self-purification did not follow any patterns, presumably from the irregularity in discharges with respect to time and space and the variability in water flow. Invertebrate communities showed stresses at some seasons and especially where tributaries enter the river. The overall self-purification properties were rated average. (Cassar-PTT) W90-04792

INFLUENCE OF PH, IONIC STRENGTH AND CHLORIDE CONCENTRATION ON THE ADSORPTION OF CADMIUM BY A SEDIMENT. Aveiro Univ. (Portugal). Dept. de Quimica. I. Boal Palheiros, A. Costa Duarte, J. P. Oliveira, and A. Hall. Water Science and Technology WSTED4, Vol 21, No. 12, p 1873-1876, 1989. 3 fig, 10 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Adsorption, *Sediments, *Cadmium, Metals, Hydrogen ion concentration, Ionic strength, Suspended solids, River beds, Chlorides.

Laboratory studies indicated that pH was more important in the control of cadmium adsorption onto riverbed sediment than ionic strength or chloride concentration. The sediment used in the study was collected from the riverbed of a small river near Aveiro, Portugal. For electrolyte concentrations less than 0.01M the ionic strength effect was more important than chloride concentration. For electrolyte concentrations of 0.01 to 0.58M the opposite was true. (Cassar-PTT) W90-04793

OUTFLOWS OF ORGANIC HALIDE PRECURSORS FROM FOREST REGIONS. Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab. For primary bibliographic entry see Field 5F. W90-04794

GEOCHEMICAL AND WATER FLOW FEATURES IN A SEMIENCLOSED EMBAYMENT OF THE WESTERN AEGEAN SEA (PAGASSITIKOS GULF, GREECE) AND PHYSICAL OCEANOGRAPHIC AND GEOCHEMICAL CONDITIONS IN THERMAIKOS BAY (NORTHWESTERN AEGEAN, GREECE). National Centre for Marine Research, Athens (Greece).

F. Voutsinou-Taliadouri, and E. T. Balopoulos. Water Science and Technology WSTED4, Vol 21, No. 12, p 1881-1886, 1989. 6 fig, 3 ref.

Descriptors: *Water pollution sources, *Greece, *Path of pollutants, *Bays, Pagassitikos Gulf, Aegean Sea, Thermaikos Bay, Sediments, Water circulation, Water currents, Heavy metals, Metals, Zinc, Nickel, Industrial wastewater, Geochemistry, Saline water.

Sediment samples and water currents were studied in Pagassitikos Gulf, a semienclosed embayment in

the Western Aegean Sea. These waters receive wastes from the city of Volos (population, 60,000) and several factories. Organic carbon content of sediments varied from 0.63 to 0.88%, the higher values being associated with fine sediments. Trace metal analyses showed no anthropogenic input from the city of Volos. High metals levels were found in some parts of the Gulf, but these were attributed to natural ore deposits. Water currents were weak (40 cm/sec). Thermaikos Bay, which receives wastes from Thessaloniki (1.2 million inhabitants), including industrial effluents was designated critically polluted. Stratification is present in spring, summer and fall. Renewal of bay waters is by intrusion of Aegean Sea saline water along the eastern coastline. The Axios River provides freshwater input. Sediments were found to be polluted with organic carbon and heavy metals, especially at river mouths and at the industrial zone. (Cassar-PTT) W90-04795

RESERVOIR SEDIMENTS AS POTENTIAL SOURCE OF HEAVY METALS IN DRINKING WATER (SARDINIA, ITALY). Cagliari Univ. (Italy). Ist. di Igiene e Medicina Preventiva. M. Schintu, N. Sechi, G. Sarritzu, and A. Contu. Water Science and Technology WSTED4, Vol 21, No. 12, p 1891-1894, 1989. 2 fig, 2 tab, 8 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Reservoirs, *Sediments, *Heavy metals, *Drinking water, *Mine drainage, Sardinia, Metals, Manganese, Cadmium, Copper, Lead, Zinc.

Heavy metals concentrations were determined in sediments from six drinking water reservoirs in Sardinia. Many of the 23 such reservoirs are located in river basins associated with mining activities. Results showed extremely high concentrations of metals in the reservoirs exposed to mining activities or with mineral deposits in the drainage basin, compared to an unexposed reservoir. Highest metals levels found in this survey (in microgram/g) were manganese, 3700; cadmium, 41.2; copper, 764; lead, 2980; and zinc, 4500. (Cassar-PTT) W90-04797

RAPID POLLUTION ASSESSMENT IN TIDAL WATERS. Southern Water Authority, Chatham (England). Kent Div. For primary bibliographic entry see Field 5A. W90-04800

AMOUNT OF HEAVY METALS DERIVED FROM DOMESTIC WASTEWATER. Yokosuka City Sewage Works Div. (Japan). K. Moriyama, T. Mori, H. Arayashiki, H. Saito, and M. Chino. Water Science and Technology WSTED4, Vol 21, No. 12, p 1913-1916, 1989. 1 fig, 3 tab.

Descriptors: *Water pollution sources, *Path of pollutants, *Heavy metals, *Wastewater composition, Metals, Cadmium, Nickel, Lead, Chromium, Manganese, Copper, Zinc, Iron, Drinking water, Domestic wastewater.

The paths of heavy metals were traced from their sources (food, tap water, detergents, cosmetics, medicine, sweat, dust, and toilet paper) to domestic wastewater (from kitchen, bath, laundry, lavatory, and others) to the wastewater plant, which discharges effluent and sludge. The amount of heavy metals was determined for cadmium, nickel, lead, chromium, manganese, copper, zinc, and iron for tap water, bath water, laundry water, kitchen waste, and feces. Metals loads were also reported for influent, effluent + sludge, and domestic wastewater on the basis of micrograms/day/person. Data were obtained and are tabulated for three Japanese cities: Yokosuka, Hachinobe, and Hakodate. (Cassar-PTT) W90-04802

FATE OF METALS LINKED WITH SEWAGE SLUDGES OR MUNICIPAL REFUSES USED

AS IMPROVEMENTS IN MARKET GARDENING.

Ministere des Transports, Nantes (France). Service des Etudes, de la Recherche et de la Technologie. For primary bibliographic entry see Field 5E. W90-04803

BIOMASS, AND NITROGEN, PHOSPHORUS, AND HEAVY METAL CONTENT OF PHRAGMITES AUSTRALIS DURING THE THIRD GROWING SEASON IN A ROOT ZONE WASTE WATER TREATMENT. Arizona State Univ., Tempe. Dept. of Botany and Microbiology. For primary bibliographic entry see Field 5D. W90-04809

RIVER QUALITY MODELING: FREQUENCY DOMAIN APPROACH. California Univ., Davis. Dept. of Land, Air and Water Resources. F. Morkoc, J. W. Biggar, R. H. Shumway, and D. R. Nielsen. Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 6, p 1008-1017, December 1989. 8 fig, 2 tab, 6 ref.

Descriptors: *Model studies, *Frequency analysis, *Rivers, *Water quality, *Specific conductivity, *Dissolved solids, *Flow discharge, *Mathematical models, Time series analysis, Frequency domain analysis, Statistical analysis, Correlation analysis.

Complete and equally spaced river quality variables specific conductance (SPC, microS/cm), total dissolved solids (TDS, mg/l), and the logarithm of the daily discharge mean (DDM, cu m/s) are used in frequency domain modeling. Significant autocorrelation values at lags 1 and 12 indicate that the observations are not random and have a yearly periodicity. Cross-correlations also indicate the yearly periodicity as well as a negative relationship between SPC and TDS. The spectral and cross-spectral analyses show a significant periodicity of $v\text{-sub-k}=0.078$ cycles per month, or a period of one year. Because these variables are linearly correlated, an impulse response function can be used to determine the lagging, leading, and/or immediate response of the input(s) on the output. It is found that the best predictor of SPC is DDM. The small contribution from TDS is ignored. Significant coherence and F statistic at a frequency of 0.093 confirms the strong linear relationship between these two variables. (Author's abstract) W90-04821

EPIDEMIOLOGY AND TOXICOLOGY OF VOLATILE ORGANIC CHEMICAL CONTAMINANTS IN WATER ABSORBED THROUGH THE SKIN. National Academy of Sciences, Washington, DC. For primary bibliographic entry see Field 5C. W90-04830

ROLE OF SKIN ABSORPTION AS A ROUTE OF EXPOSURE TO VOLATILE ORGANIC COMPOUNDS IN HOUSEHOLD TAP WATER: A SIMULATED KINETIC APPROACH. Clark Univ., Worcester, MA. Center for Technology, Environment, and Development. H. S. Brown, and D. Hattis. Journal of the American College of Toxicology JACTDZ, Vol. 8, No. 5, p 839-851, October 1989. 5 fig, 3 tab, 25 ref, append.

Descriptors: *Drinking water, *Path of pollutants, *Volatile organic compounds, *Epidermis, *Population exposure, *Domestic water, *Computer models, *Absorption, Kinetics, Water pollution effects, Hydrocarbons, Model testing, Human population, Organic compounds, Risk assessment, Simulation analysis, Estimating, Blood.

Absorption of volatile organic contaminants (VOCs) in tap water by exposure routes other than direct ingestion, such as inhalation and dermal contact, has been recognized only recently by the

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

risk assessment community. The dermal route may be a significant contributor to the total exposure to VOCs in tap water and, under some circumstances, may be its major source. A preliminary kinetic model of transdermal absorption of organic chemicals in dilute aqueous solutions has been developed. It was designed to be used on a Macintosh computer. The model was used to follow the course of absorption and distribution of three volatile organic water contaminants (ethylbenzene, toluene, and styrene) during bathing, and to estimate the associated daily dose. Comparison of calculated and experimental doses of the three VOCs absorbed dermally after 60 min (immersion of hands), was made. The doses predicted by the model under the maximum conditions were all within a factor of two or less from the experimental values, while the minimum doses differ from the experimental measurements of approximately an order of magnitude. The dermal dose was then compared with oral and inhalation doses previously estimated by other investigators. Whereas the kinetic model of skin absorption may require caution when used to estimate the absolute amount of chemical absorbed, it may be very useful when applied to estimate relative amounts absorbed by different individuals and under a variety of conditions. Such estimates, based on a kinetic model that accounts for blood flows and volumes, would produce more accurate estimates than calculations based on permeability constants for the skin. (Ver-Nooy-PTT)
W90-04831

HUMAN SKIN BINDING AND ABSORPTION OF CONTAMINANTS FROM GROUND AND SURFACE WATER DURING SWIMMING AND BATHING.

California Univ., San Francisco. Dept. of Dermatology.
R. C. Wester, and H. I. Maibach.
Journal of the American College of Toxicology JACTDZ, Vol. 8, No. 5, p 853-859, October 1989. 9 tab, 5 ref.

Descriptors: *Water pollution effects, *Groundwater, *Surface water, *Epidermis, *Absorption, *Pollutants, *Path of pollutants, *Human population, *Bioss, Domestic water, Population exposure, Hydrocarbons, Model studies, Organic compounds, Swimming, Bathing, Risk assessment.

Contaminants exist in ground and surface water. Human skin has the capacity to bind and then absorb these contaminants into the body during swimming and bathing. Powdered human stratum corneum will bind both lipid-soluble (alcohol, polychlorinated biphenyls (PCBs), benzene) and water-soluble (nitroaniline) chemicals. In vitro (human skin) and in vivo (Rhesus monkey) studies show that these chemicals readily distribute into skin, and then some of the chemical is absorbed into the body. Linearity in binding and absorption exists for nitroaniline over a 10-fold concentration range. Multiple exposure to benzene is at least cumulative. Binding and adsorption can be significant for exposures as short as 30 minutes, and will increase with time. Adsorption with water dilution increased for alcohols, but not for dinoseb. Soap reversed the partitioning of alcohols between human stratum corneum and water. The PCBs could be removed from skin by soap and water (70% efficiency) for up to 3 hours and the decontamination potential decreased, due to continuing skin absorption. The model that in vitro and in vivo systems used should permit easy estimation of this area of extensive human exposure effect on risk assessment. (Author's abstract)
W90-04832

EVIDENCE FOR COOXIDATION OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SOIL.

Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.

J. Keck, R. C. Sims, M. Coover, K. Park, and B. Symons.
Water Research WATRAG, Vol. 23, No. 12, p 1467-1476, December 1989. 2 fig, 7 tab, 36 ref. US EPA Grant R-814475-01 and Robert S. Kerr Environmental Research Laboratory, Ada, OK, Cooperative Agreement CR-810979.

Descriptores: *Biological oxidation, *Hydrocarbons, *Soil chemistry, *Biodegradation, *Polycyclic aromatic hydrocarbons, *Microbial degradation, *Fate of pollutants, Industrial wastes, Oxidation, Creosote, Loam, Water quality control, Decontamination.

The effect of constituent matrix on the degradation of hydrocarbons was characterized and evaluated within the context of cooxidation. Current information concerning two cooxidation mechanisms, analog substrate enrichment and the addition of non-analog hydrocarbon substrates, was considered in the context of biochemical degradation in situ. Non-analog hydrocarbon substrates considered included methane gas and non-specific hydrocarbons such as oil and manure. This information was used to define a laboratory approach for studying the effects of constituent matrix on degradation rates of 13 polynuclear aromatic hydrocarbons (PAHs) in soil. Four matrices were studied: single constituents applied and incubated singly; a synthetic mixture of PAHs applied and incubated together; a mixture of oil refinery wastes; and a creosote wood preserving waste. Initial soil concentrations of constituents were similar for each matrix evaluated. One soil was used, a Kidman fine sandy loam (Haplustoll, Utah). Incubation conditions and extraction and analysis methods were similar. These results can be interpreted in the context of cooxidation and suggest a potential tool for bioremediation of PAH contaminated soils and the simultaneous protection of groundwater resources through reduction or mitigation of groundwater contamination due to vadose zone-associated PAHs. (Author's abstract)
W90-04833

CHEMICAL SUBSTITUTION REACTION BETWEEN CU(II) AND HG(II) AND HYDROUS CDS(S).

Delaware Univ., Newark. Dept. of Civil Engineering.
S. W. Park, and C. P. Huang.
Water Research WATRAG, Vol. 23, No. 12, p 1527-1534, December 1989. 10 fig, 1 tab, 32 ref. Environmental Engineering Program, NSF Grant CEE 8313290 and CEE 8104728.

Descriptors: 8Water chemistry, *Cadmium, *Sulfides, *Cation exchange, *Path of pollutants, *Mercury, *Copper, Chemical reactions, Heavy metals, Water pollution, Electrophoresis, Adsorption, Chemical precipitation, Solubility, Interference.

Increases in the industrial use of metal sulfides, including the use of cadmium sulfide to utilize solar energy, may increase the fluxes of heavy metal into aquatic systems. Insights into the surface chemistry of CdS(s) has far reaching implications in environmental pollution control and the harvest of solar energy. The chemical reaction between hydrous CdS(s) and Cu(II) and Hg(II) were studied by electrophoretic mobility measurements and adsorption experiments. The results show that cation exchange, following readsorption of the released Cd(II) ions onto the freshly-formed CuS(s) and cadmium hydroxide precipitation reactions occur when CdS particles come into contact with these metal ions which have sulfide precipitates less soluble than CdS(s). The effect of organic ligands on the ion exchange reaction, exemplified by EDTA (a strong complexing ligand) and phthalic acid (a weak complexing ligand), was also investigated. Both organic compounds have little effect on the lattice ion exchange reaction unless a large amount of strong complexing agent is present in the system. The dissolution of CdS(s), however, is slightly hindered in the presence of weak complex former such as phthalic acid and greatly enhanced in the presence of strong complex former such as EDTA. (Author's abstract)
W90-04841

EFFECT OF SURFACE ACTIVE SUBSTANCES ON THE ELECTROCHEMICAL BEHAVIOUR OF COPPER IONS IN CHLORIDE SOLUTIONS AND IN NATURAL WATERS.

Institut Rudjer Boskovic, Zagreb (Yugoslavia).

Center for Marine Research.

For primary bibliographic entry see Field 2K. W90-04843

UPTAKE AND DEPURATION OF 241AM, 239+240PU, 238PU, 137CS AND 106RU BY MYTILUS EDULIS UNDER NATURAL STRESS.

Marine Biological Association of the United Kingdom, Plymouth (England).
R. J. Clifton, H. E. Stevens, and E. I. Hamilton.
Marine Ecology Progress Series MESEDT, Vol. 54, No. 1-2, p 91098, June 1989. 4 fig, 3 tab, 30 ref. European Economic Community, Contracts B16-R-038-UK and B19-B-438-81-UK.

Descriptors: *Mollusks, *Path of pollutants, *Depuration, *Mussels, *Radioisotopes, *Bioaccumulation, *Stress, Tissues, Americium, Cesium, Plutonium, Ruthenium, Mytilus.

Rates of uptake of 241Am, 137Cs and 106Ru by both the soft tissue and the shell of transplanted Mytilus edulis L. were determined; soft tissue data were compared to theoretically derived values based on the biological half-life and the steady state concentration of these isotopes. The rates of loss of 241Am, 239+240Pu, 238Pu, 137Cs and 106Ru by M. edulis under conditions of stress, manifest as extended periods of shell closure as a consequence of high ambient concentrations of copper and zinc and extended periods of aerial exposure, were examined. Both types of stress did not significantly alter the rate of loss of the Pu isotopes, 137Cs or 106Ru from the flesh of the mussel but the 241Am concentration increased significantly over the depuration period of February to June—a probable consequence of the remobilization of 241Am associated with the inner nacreous layer of the shell. Concentrations of radionuclides approached steady state values more rapidly in the shell than in the total soft tissues of the mussel. (Author's abstract)
W90-04869

STABLE ISOTOPE RATIOS AND CONTAMINANT CONCENTRATIONS IN A SEWAGE-DISTORTED FOOD WEB.

Lawrence Livermore National Lab., CA. Environmental Sciences Div.

R. B. Spies, H. Kruger, R. Ireland, and D. W. Rice.
Marine Ecology Progress Series MESEDT, Vol. 54, No. 1-2, p 157-170, June 1989. 6 fig, 9 tab, 46 ref. DOE Contract W-7405-ENG-48; EPA Interagency agreement AD-89-EA267.

Descriptors: *Path of pollutants, *Fish physiology, *Bioaccumulation, *Municipal wastes, *Food chains, Organic matter, Nitrogen, Carbon, Phthalates, Chlorinated hydrocarbons, Radioisotopes.

Concentrations of selected neutral organic contaminants and stable isotope ratios of carbon, nitrogen and deuterium/hydrogen in invertebrates and fish were compared from near a large, 60 m deep municipal waste outfall near Los Angeles, CA, and from a reference area off Santa Barbara, CA. Objectives were to investigate: (1) the degree of utilization of sewage organic matter in the food web, especially by three species of fish; (2) differences in contaminant accumulation between these benthophagous fish; and (3) the behavior of organic contaminants relative to each other and to organic matter through several trophic levels. On the basis of the stable isotope ratio (delta) 13C and (delta) 15N of the fishes, the estimated contribution of nitrogen and carbon from sewage was about 15-20% of their requirements for these elements. The delta 13C and delta 15N values increased in the fishes in the order of Microstomus pacificus, Citharichthys sordidus and Zanolepis latipinnis. The Cs/K ratio of Z. latipinnis was also significantly higher than for the other two species, also indicating its higher trophic position. C. sordidus had the highest wet-weight concentrations of chlorinated hydrocarbons and phthalic acid esters; intermediate concentrations of these compounds were found in Z. latipinnis and the lowest concentrations were found in M. pacificus. Concentrations of chlorinated hydrocarbons on a lipid-weight basis changed

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this order so that it more closely resembled the trophic structure revealed by the stable isotope ratio and Cs/K data. A large degree of correlation was evident between contaminants in *Z. latipinnis* but not in the other 2 fish species. These correlations were apparently not a function of liver lipid concentration, but the strengths of the correlations were dependent on the similarities of logK sub ow values of the correlated compounds. (Author's abstract)

W90-04872

MICRO-ALGAE OF LAKE PUPUKE, AUCKLAND, NEW ZEALAND.

Department of Scientific and Industrial Research, Auckland (New Zealand). Botany Div.
For primary bibliographic entry see Field 2H.

W90-04873

AGRICULTURAL CONTAMINATION: PROBLEMS AND SOLUTIONS.

Agricultural Research Service, Phoenix, AZ.
Water Conservation Lab.

H. Bouwer.
Water Environment and Technology, Vol. 1, No. 2, p 292-297, October 1989. 1 fig.

Descriptors: *Water pollution sources, *Nonpoint pollution, *Water pollution control, *Path of pollutants, *Agricultural chemicals, *Pesticides, *Groundwater pollution, *Irrigation effects, Legislation, Leaching, Salt balance, Trace elements, Fertilizers, Salts.

Salts from irrigation water concentrate in the deep-percolation water and can pollute groundwater, especially in dry climates where there is little natural dilution. Under certain geologic conditions, selenium and other trace elements may leach from the root and vadose zones into the groundwater. Salt and trace element contamination is a direct result of agricultural activities, but neither is caused by anthropogenic chemicals, such as nitrate and pesticides which can cause severe groundwater contamination. Growing concern over groundwater contamination caused by fertilizer and pesticide use has triggered an increase in legislative and regulatory activity. Contamination migration must be better understood so that pesticide transport can be more accurately predicted. Preventing contamination is more effective than cleaning polluted aquifers. Realistic regulatory policies and management practices that will protect public health while ensuring viable and sustainable agriculture must be implemented. Health effects and complications associated with well contamination include methemoglobinemia and cancer risks. Legislation has been enacted to help relieve some contamination problems on both state and federal levels. Problems associated with bioassays, acceptable risk and maximum contaminant limits include: (1) extrapolation from animal studies that may not be applicable to humans; (2) use of a single chemical, ignoring synergistic effects; and (3) no reliable means for quantifying risk factors. Solutions for preventing groundwater contamination require more emphasis on research as well as extensive treatment of contaminated groundwater. (Male-PTT)

W90-04876

ECOLOGY AND SURVIVAL OF LEGIONELLA PNEUMOPHILA.

Thames Water Authority, London (England).
J. S. Colbourne, and P. J. Dennis.
Journal of the Institution of Water Engineers and Scientists IIWSDI, Vol. 3, No. 4, p 345-350, August 1989. 1 fig, 5 tab, 37 ref.

Descriptors: *Pathogenic bacteria, *Bacteria, *Drinking water, *Pathogenic bacteria, *Legionnaires disease, Survival, Legionella, Disinfection, Bacterial analysis.

Legionella pneumophila serogroup 1 was detected in 12% of water sources used for the supply of drinking water in England in a survey carried out between September 1985 and June 1987. The bacterium, the causative agent of legionnaires' disease, was found more often in underground supplies in late summer-early autumn: the time of year when

indigenous community-acquired infections also increase in number. Using an immunofluorescent assay it was observed that *L. pneumophila* could survive conventional water treatment including disinfection with chlorine and, while being non-culturable, retained its ability to colonize pipe surfaces and grow in the warmer water systems of buildings. Viability of non-culturable *Legionella* was demonstrated by heat shock. These findings confirm the importance of preserving water quality within buildings by good design, thorough maintenance, and careful operation of water systems, following the guidance issued by the Department of Health and the Health & Safety Executive. (Author's abstract)

W90-04905

TOXICS: TODAY'S GREAT LAKES CHALLENGE.

For primary bibliographic entry see Field 2H.

W90-04930

SURVIVAL OF VIBRIO VULNIFICUS IN SHELLSTOCK AND SHUCKED OYSTERS (CRASSOSTREA GIGAS AND CRASSOSTREA VIRGINICA) AND EFFECTS OF ISOLATION MEDIUM ON RECOVERY.

Food and Drug Administration, Bothell, WA. Seafood Products Research Center.

C. A. Kaysner, M. L. Tamplin, M. M. Wekell, R. F. Stott, and K. G. Colburn.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3072-3079, December 1989. 7 fig, 2 tab, 27 ref.

Descriptors: *Food processing industry, *Oysters, *Vibrio, *Pathogenic bacteria, *Contamination, Food poisoning, Mollusks, Survival, Food contamination, Refrigeration, Pathogens.

When two species of shellstock oysters were artificially contaminated with *Vibrio vulnificus*, the bacterium survived when the oysters were stored at 10°C and below. Large numbers of endogenous *V. vulnificus* cells were found after 7 days at both 0.5 and 10°C in uninoculated control oysters (*Crassostrea virginica*). Oysters allowed to take up *V. vulnificus* from seawater retained the bacterium for 14 days at 2°C. The presence of *V. vulnificus* in the drip exuded from the shellstock presented a possibility of contamination of other shellstock in storage. *V. vulnificus* injected into shucked Pacific (*Crassostrea gigas*) and Eastern (*C. virginica*) oysters survived at 4°C for at least 6 days. An 18-hour most-probable-number enrichment step in alkaline peptone water gave higher recovery levels of *V. vulnificus* than did direct plating to selective agars. The survival of this pathogen in both shellstock and shucked oysters suggests a potential for human illness, even though the product in refrigerated.

(Author's abstract)

W90-04932

REQUIREMENT FOR A MICROBIAL CONSORTIUM TO COMPLETELY OXIDIZE GLUCOSE IN FE(III)-REDUCING SEDIMENTS.

Geological Survey, Reston, VA. Water Resources Div.

For primary bibliographic entry see Field 2H.

W90-04936

RELATIONSHIPS AMONG TRIHALOMETHANE FORMATION POTENTIAL, ORGANIC CARBON AND LAKE ENRICHMENT.

Pittsburg State Univ., KS. Dept. of Biology.
J. A. Arruda, and C. H. Fromm.
Environmental Pollution ENPOEK, Vol. 61, No. 3, p 199-209, 1989. 4 fig, 2 tab, 27 ref.

Descriptors: *Chlorination, *Carcinogens, *Drinking water, *Trihalomethanes, *Kansas, Organic carbon, Chemical reactions, Eutrophic lakes, Turbidity, Eutrophication, Disinfection.

Trihalomethanes are potential carcinogens formed from the reaction of the disinfectant chlorine with organic matter in the source water. This study of Kansas drinking water supply lakes evaluates the relationship among trihalomethane formation po-

tential, organic carbon and lake trophic state. Kansas community water supply lakes are small artificial impoundments, usually serving fewer than 5000 people. Six lakes were chosen for intensive study and sampled 11 times at biweekly intervals from the end of April 1984 to the middle of September 1984 and seven times at monthly intervals from April 1985 to October 1985. Nine additional lakes were sampled four times, in May, August and October 1985 and in May or April 1986. Trihalomethane formation potential was positively correlated to organic carbon. Total trihalomethane formation potential and total organic carbon were positively correlated to lake trophic state, an estimator of lake enrichment, when very turbid lakes were omitted. These very turbid lakes (due to high suspended solids concentrations) had higher than expected trihalomethane formation potential, based on lake trophic state and higher organic carbon concentrations. Trihalomethane data measured in the treated drinking water were positively correlated to trihalomethane formation potential, total organic carbon and lake trophic state. The levels of organic carbon that contribute to trihalomethanes are a result of lake and watershed factors related to increasing levels of enrichment and suspended sediments. These factors are controllable by appropriate management practices. (Mertz-PTT)

W90-04942

CHANGES IN CONCENTRATION OF LEAD AND CADMIUM IN WATER FROM THREE RIVERS IN DERBYSHIRE.

Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.

P. E. T. Douben.

Environmental Pollution ENPOEK, Vol. 61, No. 3, p 211-226, 1989. 5 fig, 4 tab, 32 ref.

Descriptors: *Rivers, *Cadmium, *Lead, *Heavy metals, *Water pollution, *Path of pollutants, *England, *Suspended sediments, Sediments, River flow, Seasonal variation, Flow rates, Water pollution sources.

River water from three sites in three different streams in Derbyshire was sampled during April, July, August, and November, 1987 to evaluate fluctuations in cadmium and lead concentration. The results indicate that most of the cadmium was in solution, while most of the lead was associated with particles at all sites. Period of sampling appeared to have a greater effect on the concentration of cadmium and lead than flow rate: metal levels were higher in spring than in autumn. Nevertheless, the total lead concentration increased with flow rate, presumably because more particles were then brought into suspension. However, the lead concentration in the filtrate was reduced at higher flow rates, presumably due to dilution in the greater water volume. Dissolved cadmium concentration increased with rising flow rate at relatively low flow rates and was diluted at high flow rates. The data suggest that particles with which most of the lead is associated remain in suspension for a considerable time even when flow rate decreases. (Author's abstract)

W90-04943

RESIDUES OF PHOSPHAMIDON IN RICE FIELDS.

Madurai-Kamaraj Univ. (India). Dept. of Biochemistry.

S. R. D. Jebakumar, N. Kannan, B. R. Subramanian, and J. Jayaraman.
Environmental Pollution ENPOEK, Vol. 61, No. 3, p 227-234, 1989. 1 fig, 2 tab, 12 ref.

Descriptors: *Pesticide residues, *Agricultural chemicals, *Pesticides, *Rice, *Tolerance limits, Gas liquid chromatography, Crops, Food contamination, Phosphamidon.

Phosphamidon is a pesticide used at heading stage in rice fields against stem borers that is widely used in India. Thirty-day-old seedlings of rice plants (IR-20 variety) from the nursery were transplanted into experimental plots and after 52 days were sprayed with phosphamidon at two dose-rates

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(0.38 kg a.i./ha and 0.76 kg a.i./ha). Residues of phosphamidon in the plant, soil and water were analysed by gas liquid chromatography, at various time intervals, and were found to decrease steadily up to 15 days. A second application of the pesticide was made on day 113 and grains harvested on day 138. The residue level in the plants was 0.12 microgram/g and in the grains 0.04 micrograms/g with the high dose. This is slightly below the EPA prescribed tolerance level of 0.05 microgram/g. The residues in both soil and water were very low 24 hours after spraying. (Mertz-PTT)
W90-04944

TRACE ELEMENTS AND CHLORINATED HYDROCARBONS IN EGGS OF PELECANUS CRISPUS, A WORLD ENDANGERED BIRD SPECIES NESTING AT LAKE MIKRI PRESIPA, NORTH-WESTERN GREECE.

Station Biologique de la Tour du Valat, Arles (France).

A. J. Crivelli, S. Focardi, C. Fossi, C. Leonzio, and A. Massi.

Environmental Pollution ENPOEK, Vol. 61, No. 3, p 235-247, 1989. 1 fig, 5 tab, 30 ref.

Descriptors: *Path of pollutants, *Chlorinated hydrocarbons, *Birds, *Eggs, *Pesticides, *Greece, *DDE, *Polychlorinated biphenyls, *DDT, Monitoring, Pelicanus, Fish, Endangered species, Pesticide residues, Water pollution effects.

Eggs of the Dalmatian pelican, *Pelecanus crispus*, collected from 1984 to 1986 at Lake Mikri Prespa, north-western Greece, contained residues of trace elements and polychlorobiphenyls (PCBs) at low concentrations, and of DDE at rather high concentrations. DDE is negatively related to eggshell thickness. Eggshell thickness was reduced by 12-20% in comparison with the pre-1947 (before dichlorodiphenyltrichloroethane (DDT) use) eggshell thickness. However, this decrease did not affect the reproductive success of this species. The main fish species eaten by the Dalmatian pelican at Lake Mikri Prespa were analyzed for pollutants. All the fish contained low concentrations of residues. The contribution of the diet while the birds are on the wintering grounds is unknown. Because the Dalmatian pelican is a world-endangered species, the authors recommend that a monitoring program be set up at Lake Mikri Prespa and other sites. At 3-year intervals, the eggshell thickness should be measured using a portable nondestructive beta-backscatter device and unhatched eggs should be collected for chemical analysis. Unhatched eggs are recommended since studies have shown no differences in the contaminant levels between embryonated and added eggs. (Mertz-PTT)
W90-04945

DDT IN MYTILUS EDULIS: STATISTICAL CONSIDERATIONS AND INHERENT VARIABILITY.

Universidad Autonoma de Baja California (Mexico). Inst. de Investigaciones Oceanologicas. For primary bibliographic entry see Field 5A.
W90-04965

METALS AND ORGANOCHLORINES IN DOLPHINS AND PORPOISES OF CARDIGAN BAY, WEST WALES.

Cetacean Research Group, Swanage (England). R. J. Morris, R. J. Law, C. R. Allchin, C. A. Kelly, and C. F. Fileman.

Marine Pollution Bulletin MPNBZ, Vol. 20, No. 10, p 512-523, October 1989. 2 fig, 5 tab, 53 ref.

Descriptors: *Path of pollutants, *Marine mammals, *Heavy metals, *Bioaccumulation, *Wales, *Pesticides, *Polychlorinated biphenyls, Food chains, Cetaceans, Forpoises, Seals, Dolphins, Chromium, Nickel, Copper, Zinc, Cadmium, Mercury, Lead, Pollutants, Water pollution effects.

Concentrations of seven metals (Cr, Ni, Cu, Zn, Cd, Hg, and Pb) and a range of organochlorine pesticides, individual chlorobiphenyl congeners, and total polychlorinated biphenyls have been determined in tissues of dolphins, porpoises, seals, and a variety of food chain species and sediments

from Cardigan Bay, West Wales. Elevated concentrations of metals were not seen in any of the animal tissues examined. Higher than expected levels of organochlorine compounds were found in tissues of dolphins and porpoises; these concentrations are not derived from local pollution, but come from the animals' normal diet which did not show markedly elevated levels of organochlorines. The level of organochlorine bioaccumulation seen in some of the cetaceans analyzed is much higher than found previously; this may have serious health implications from populations of those species around the coasts of Northwestern Europe. (Author's abstract)
W90-04968

ECOLOGY OF THE LAMBRO RIVER.

Milan Univ. (Italy). Ist. di Biologia.

For primary bibliographic entry see Field 2H.
W90-04969

CADMIUM LEVELS IN OYSTERCATCHER HAEMATOPUS OSTRALEGUS FROM THE GERMAN WADDEN SEA.

Osnabrueck Univ. (Germany, F.R.). Dept. of Ethology.

M. Stock, R. F. M. Herber, and H. M. A. Geron. Marine Ecology Progress Series MESED, Vol. 53, No. 3, p 227-234, 1989. 3 fig, 2 tab, 56 ref.

Descriptors: *Cadmium, *Water birds, *Water pollution, *West Germany, *Bioaccumulation, Electrothermal atomization absorption spectrometry, German Wadden Sea.

Cadmium levels of kidney and liver tissues of 150 oystercatcher frost victims from the German Wadden Sea area were determined by means of electrothermal atomization absorption spectrometry. Overall median kidney values amounted to 11.9 microgram/g, those of liver to 4.9 microgram/g. Because of tissue wastage, levels may be somewhat elevated compared to those in healthy birds. Females accumulated less cadmium than males. Accumulation of hepatic and renal cadmium was age-dependent, with subadult birds having significantly higher amounts than juveniles. There was no difference on concentration between subadult and adult birds. Overall, cadmium concentrations in kidney and liver were strongly, positively, linearly correlated. No correlation was found between feather and tissue cadmium concentrations. (Author's abstract)
W90-04978

TREND MONITORING OF DISSOLVED TRACE METALS IN COASTAL SEA WATER: A WASTE OF EFFORT.

Marine Lab., Aberdeen (Scotland).

P. W. Balls. Marine Pollution Bulletin MPNBZ, Vol. 20, No. 11, p 546-548, November 1989. 2 fig, 21 ref.

Descriptors: *Monitoring, *Path of pollutants, *Coastal waters, *Water pollution, *Trace metals, *Heavy metals, Lead, Cadmium.

The dynamic nature of the marine environment with its constant throughput of water and particles acts to reduce the magnitude of changes in dissolved trace metal concentrations arising from changes in inputs. This blurring of the signal is greatest in turbid areas for particle reactive materials such as lead. Only in essentially free ocean waters with long residence times and a dominant atmosphere source have changes been detected for this element. Trend monitoring of dissolved trace metals is only possible for elements such as cadmium which have low particle reactivity. Even then the monitoring could only be useful in areas of low turbidity. Since such monitoring is of such limited value effort, resources are better directed towards process oriented research on order to better understand the transport and cycling of trace metals in the marine environment. (Author's abstract)
W90-04982

ESTIMATES OF TRACE METAL INPUTS FROM NON-POINT SOURCES DISCHARGED INTO ESTUARIES.

National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.

A. J. Paulson, H. C. Curl, and R. A. Feely. Marine Pollution Bulletin MPNBZ, Vol. 20, No. 11, p 549-555, November 1989. 5 fig, 1 tab, 27 ref.

Descriptors: *Nonpoint pollution sources, *Path of pollutants, *Water pollution sources, *Trace metals, *Copper, *Zinc, *Lead, *Washington, *Cadmium, *Nickel, *Iron, Shipyards, Elliott Bay, Duwamish Waterway, Industrial wastewater, Municipal wastewater.

Elliott Bay and the Duwamish Waterway, Washington, were sampled for dissolved trace metals during a period of wet weather in January 1986. High concentrations of dissolved Cu, Zn, Pb, Cd and less elevated concentrations of dissolved Ni were found in marine waters adjacent to operating shipyards and a combined sewer overflow pipe that was discharging. Changes in the transports of dissolved trace metals, which have been deduced from trace metal-salinity plots, were attributed to emissions from anthropogenic sources. While 65% of the dissolved Cu and Zn transported from Elliott Bay were attributed to emissions from shipyards along Elliott Bay's shoreline, an additional 30% of the Zn was added by industrial areas adjacent to waterways supplying freshwater. Only 20% of the Elliott Bay dissolved Ni transport was contributed by shoreline sources. In contrast, anthropogenic sources did not increase the transport of dissolved Fe. (Author's abstract)
W90-04983

RELATIVE CONCENTRATIONS OF DISSOLVED/DISPERSED FOSSIL FUEL RESIDUES IN MEDITERRANEAN SURFACE WATERS AS MEASURED BY UV FLUORESCENCE.

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.

For primary bibliographic entry see Field 5A.
W90-04985

TRENDS IN OIL SPILL INCIDENTS IN SOUTH AFRICAN COASTAL WATERS.

Sea Fisheries Research Inst., Rogge Bay (South Africa).

A. Moldan, and A. Dehrman.

Marine Pollution Bulletin MPNBZ, Vol. 20, No. 11, p 565-567, November 1989. 3 fig, 2 tab, 3 ref.

Descriptors: *Water pollution, *Coastal waters, *Oil spills, *Water pollution control, *South Africa, Oil tankers, Aircraft, Ships.

South Africa, situated on one of the world's major shipping routes, is constantly subjected to contamination of its coastal waters by oil slicks emanating from passing traffic. Due to a growing awareness of the potential threat posed to the marine and coastal environments by both the larger accidental spills, as well as the smaller operational spills discharged from vessels other than tankers, in 1973 the Department of Transport entered into a 15-year contract with a shipping group for the provision of 5 dedicated oil pollution patrol/dispersant spraying vessels. These vessels, although very effective in combating oil spills at sea, were less effective in detecting and apprehending ships illegally discharging oil at sea, during routine coastal patrols. In 1984 one of these vessels was replaced by a patrol aircraft which proved to be highly effective in coastal patrol work. Between 1984 and 1987 the aircraft spotted one oil spill approximately every 3.5 flying hours. During 1988 the number of sightings dropped to one spill every 5.7 flying hours, indicating that the patrols are acting as a deterrent as ship masters have become more aware of these patrols along the coastline. Analyses of the types of vessels found discharging oil indicates that bulk carriers make up 42%, general cargo vessels 24% and oil tankers 16% of the spills. Temporal and spatial analysis of the spills does not indicate any significant trends. Spills are recorded throughout the year without any peaks during particular months. In addition to reports received from the patrol aircraft, a number of reports of oil slicks

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sightings are received from other sources such as military and commercial aircraft, ships at sea, port captains, etc. To date, 18 ship's masters have been prosecuted or paid admissions of guilt for illegally discharging oil in South African waters. (Sand-PTT)
W90-04986

CONDITION OF CORAL REEF CNIDARIANS FROM THE NORTHERN FLORIDA REEF TRACT: PESTICIDES, HEAVY METALS, AND HISTOPATHOLOGICAL EXAMINATION.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Biology and Living Resources.
P. W. Glynn, A. M. Szmant, E. F. Corcoran, and S. V. Cofer-Shabica.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 11, p 568-576, November 1989. 3 fig, 4 tab, 38 ref.
National Park Service contract CX 5280-5-1447.

Descriptors: *Corals, *Reefs, *Coastal waters, *Water pollution effects, *Halogenated pesticides, *Heavy metals, *Urban runoff, *Agricultural runoff, Lindane, Heptachlor, Chlordane, DDT, Arsenic, Copper, Lead, Biscayne National Park, Florida.

Scleractinian corals and octocorals from two reefs within Biscayne National Park off southeast Florida were compared with respect to relative abundances, gross field condition, concentrations of pesticides and heavy metals, and histopathological condition. The northernmost reef, Bache Shoal, is near a large urban area (Miami) and potentially receives pollutants from this source. The southernmost reef, Alina's Reef, is less likely to be influenced by runoff from Miami, but may receive runoff from an important agricultural center (Homestead). No consistent differences between the two coral reef communities were found; however, high frequencies of blemishes and abnormalities (bite marks, unusual growth forms, bleached tissue), tissue necrosis, and invading pathogens were evident at both sites. Additionally, high levels (to ppm) of organochlorine pesticides (lindane, heptachlor/heptachlor epoxide, alpha/gamma-chlordane, and DDT residues) and heavy metals (As, Cu, Pb) were detected in several of the reef core/termites from both sites. (Author's abstract)
W90-04987

TOTAL MERCURY AND CADMIUM IN SOME CEPHALOPODS AND FISH FROM THE ADRIATIC SEA.

J. Sapunar, M. Jusic, and D. Bazulic.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 11, p 576-577, November 1989. 1 tab, 8 ref.

Descriptors: *Water pollution, *Mercury, *Cadmium, *Fish, *Cephalopods, *Mollusks, *Adriatic Sea, *Path of pollutants.

A survey was carried out in 1988 to establish the differences between Hg and Cd concentrations in cephalopod and fish samples from industrially polluted Kastela and Rijeka bays and a control area of the Adriatic Sea. Significantly higher Hg and Cd concentrations ($P < 0.01$ and $P < 0.1$, respectively) were detected in the polluted than control area cephalopod catches. The same significant difference ($P < 0.01$) was observed for Hg in fishes, but no differences were found in the same samples for Cd. The results confirm previous reports of high Hg concentrations in the species examined in the same polluted areas in the Adriatic sea. It is concluded that higher consumption of this type of seafood can easily lead to an excess in the provisionally tolerable weekly intake for Hg. (Sand-PTT)
W90-04988

NONPOINT SOURCE POLLUTION CONTROL EFFECTIVENESS OF RIPARIAN FORESTS ALONG A COASTAL PLAIN RIVER.

East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
For primary bibliographic entry see Field 5G.
W90-04999

REVIEW OF FARM WASTE POLLUTION.

For primary bibliographic entry see Field 5G.
W90-05014

CONTAMINATION OF GROUNDWATERS FROM DIFFUSE SOURCES ARISING FROM FARMING ACTIVITIES.

Southern Water Authority, Worthing (England).
H. G. Headworth.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 3, No. 5, p 517-521, October 1989. 2 tab, 17 ref.

Descriptors: *Nonpoint pollution sources, *Groundwater pollution, *Water pollution sources, *Agricultural runoff, Leaching, Regulations, Water pollution effects, Public health, Fertilizers, Path of pollutants, Pesticides, Phosphates, Nitrates, Aquifers.

Diffuse sources of pollution, such as pesticides and fertilizers pose a greater threat to groundwater quality than point sources of pollution. The hydrogeological processes which take place in soils and aquifers to alter, attenuate and absorb contaminants need to be appreciated to understand the risk which aquifers face from pollutants. This is particularly so in the case of pesticides, which are seen as a growing long-term threat to the security of aquifers. Monitoring of United Kingdom aquifers has found eleven of the thirty-four pesticides analyzed above the detection limit. The maximum concentrations found exceed 0.2 micrograms/liter in five of the compounds (mecoprop, 2,4-D, simazine, atrazine and propazine) and these have a largely non-agricultural origin. This low incidence of occurrence and concentration is due to the breakdown and immobility of the pesticides through soils and underground strata. Rising nitrate concentrations cause the greatest concern to groundwater quality in several parts of England, in particular the Midlands and East Anglia. An increasing number of sources contain nitrate exceeding the EC (European Community) limit. Despite the tenuous evidence for medical harm associated with methemoglobinemia and stomach cancer, the water authorities must comply with a limit (50 milligrams/liter) which will not be raised, but may be lowered. Although the Government is considering introducing measures to control land use thereby reducing leaching losses from inorganic nitrogen fertilizers, the water undertakings will be obliged to bear the burden of statutory compliance by means of blending, treatment and the use of alternative sources. (Geiger-PTT)
W90-05019

DRAINAGE OF LANDFILL COVERS AND BOTTOM LINERS: UNSTEADY CASE.

Kansas Univ., Lawrence. Dept. of Civil Engineering.
B. M. McEnroe.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1103-1113, December 1989. 6 fig, 8 ref, append. University of Kansas General Research Allocation No. 3730-20-0038.

Descriptors: *Landfill covers, *Landfill liners, *Waste disposal, *Path of pollutants, *Landfills, *Leakage, *Unsteady flow, *Mathematical models, Hydraulic conductivity, Drainage, Porosity, Unsteady flow, Clays.

A simple model for estimating leakage through a compacted clay barrier for a single inflow event is presented. This algebraic model yields estimates of leakage fraction that compare closely with those obtained by solving the governing partial differential equation numerically. The algebraic model exhibits negligible bias and a standard error of estimate of less than 20% over its range of applicability. In most practical cases, the leakage fraction for a single inflow event is largely determined by the value of a single dimensionless parameter termed the leakage number. This parameter accounts for the hydraulic conductivities of the drainage layer and barrier, the lateral drainage distance, the barrier slope, the drainage-layer porosity, and the inflow volume. The effects of inflow duration and barrier thickness on leakage tend to be relatively minor. The practical application of the leakage

model is illustrated in an evaluation of a proposed final-cover design for a solid waste landfill. (See also W90-05021) (Author's abstract)
W90-05020

STEADY DRAINAGE OF LANDFILL COVERS AND BOTTOM LINERS.

Kansas Univ., Lawrence. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-05021

PCE VOLATILIZED FROM STAGNANT WATER AND SOIL.

Clayton Environmental Consultants Ltd., Windsor (Ontario).
R. G. Zytner, N. Biswas, and J. K. Bewtra.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1199-1212, December 1989. 5 fig, 3 tab, 19 ref, append.

Descriptors: *Path of pollutants, *Volatility, *Fate of pollutants, *Organic solvents, *Stagnant water, *Soil contamination, Water pollution, Organic carbon, Theoretical analysis, Soil gases, Gas chromatography, Perchloroethylene, Volatile organic compounds, Soil chemistry, Organic carbon.

Batch equilibrium studies were conducted under controlled laboratory conditions to determine the volatilization rate for perchloroethylene (PCE) from water and soil. The volatilization of PCE from water was evaluated by filling different-size glass beakers with the prepared PCE solutions of 18.75, 37.5, and 75.0 milligrams/liter concentrations. The beakers were filled to obtain area-to-volume ratios of 2.08, 22.4, 50.0, and 81.0/m and samples were withdrawn every 30 min for analysis by gas chromatography. The volatilization studies for soil were conducted in a manner similar to those for water with certain minor modifications. Three different sizes of gas chromatography vials were used for the soil experiments, providing cross-sectional area-to-volume ratios of 0.377, 0.77, and 1.43/m. The use of gas chromatography vials permitted the capping of vials at the required time intervals, and subsequently it allowed the gas to collect in the vial headspace before analysis by gas chromatography to determine the amount of PCE remaining in the soil. The PCE volatilized rapidly from water with a rate constant that increased with an increase in area to volume ratio that was independent of aqueous PCE concentration. Rate constants determined in this study indicate that aqueous PCE volatilizes faster from soil than from water. However, volatilization from soil depends not only on area to volume ratio but also on the presence of organic carbon and concentration of aqueous PCE applied to the soil. The greater the organic carbon of soil media content, the slower is the rate of volatilization. The rate of volatilization of pure PCE from soil is comparatively low and is greatly retarded by organic carbon content of the soil. A flux experiment is also carried out with pure PCE. The results indicate a low flux rate of submerged PCE into a stagnant water column (0.028 kilograms/sq m/day). (Geiger-PTT)
W90-05027

SEASONAL AND LONG-TERM VARIATIONS OF DISSOLVED SOLIDS IN LAKES AND RESERVOIRS.

Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
For primary bibliographic entry see Field 2H.
W90-05028

MODEL ILLUSTRATING THE ENVIRONMENTAL FATE, EXPOSURE AND HUMAN UPTAKE OF PERSISTENT ORGANIC CHEMICALS.

Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
S. Paterson, and D. Mackay.
Ecological Modelling ECMODT, Vol. 47, No. 1/2, p. 85-114, September 1, 1989. 2 fig, 7 tab, 24 ref, append.

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Descriptors: *Path of pollutants, *Fate of pollutants, *Water pollution effects, *Toxicity, *Air pollution effects, Model studies, Bioaccumulation, Computer models, Air, Water, Sediments, Soil contamination, Foods.

A multimedia partitioning model, implemented on a microcomputer, describes sequentially the environmental distribution of, animal and human exposure to, and bioconcentration potential of, relatively persistent organic chemicals in southern Ontario. The model depicts the complete pathways of a chemical after release, including distribution in various environmental media of air, water, sediment, soil and food, the chemical availability to herbivores and humans with consequent estimation of exposure, and its bioconcentration potential in human adipose tissue. The calculated exposures can be compared to those which are judged to have toxic or other effects, and a corresponding safety factor can be estimated. The concepts of estimating critical or multiple exposure routes and the effect of regulating environmental emissions are illustrated. In order to treat this complex issue, the model contains a number of simplifying assumptions; thus it gives no better than order-of-magnitude accuracy. Its principal benefit is its quantification and illustration of the entire process of environmental partitioning, exposure and uptake, and comparison with toxicological and other criteria. (Author's abstract)
W90-05041

EXPOSURE AND ECOTOXICITY ESTIMATION FOR ENVIRONMENTAL CHEMICALS (E4CHEM): APPLICATION OF FATE MODELS FOR SURFACE WATER AND SOIL.

Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Umweltgefahrungs-schritte von Chemikalien.
M. Matthies, R. Bruggemann, B. Munzer, G. Schernewski, and S. Trapp.
Ecological Modelling ECOMODT, Vol. 47, No. 1/2, p. 155-130, September 1, 1989. 8 fig, 5 tab, 22 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Herbicides, *Chemical wastes, Model studies, Volatilization, Comparison studies, Wastewater disposal.

The E4CHEM (Exposure and Ecotoxicity Estimation for Environmental Chemicals) model system was developed for exposure and hazard assessment of environmental chemicals. Two E4CHEM fate models, EXWAT and EXSOL, for surface waters and soil, respectively, are tested and validated by comparing experimental with calculated results. The concentrations of a volatile compound (tetrachloroethene) in the river Main can be predicted by EXWAT, taking into account the average consumption values along the river and an empirically derived proportionality factor for the release rate (0.6% for tetrachloroethene). A sensitivity analysis shows the dominance of volatilization over dilution. The transport and fate of the herbicide, 2,4,5-trichlorophenoxyacetic acid, are simulated for four German soils under various climatic conditions. Downward movement is underestimated by laboratory sorption measurements. Sorption coefficients derived from field trials have lower values and lower variabilities than those from laboratory sorption studies. (Author's abstract)
W90-05042

FAST GRAPHICAL SIMULATIONS OF SPILLS AND PLUMES FOR APPLICATION TO THE GREAT LAKES.

Guelph Univ. (Ontario). Dept. of Computing and Information Science.
I. Wong, D. A. Swaine, C. R. Murthy, and D. C. L. Lam.
Ecological Modelling ECOMODT, Vol. 47, No. 1/2, p. 161-173, September 1, 1989. 5 fig, 6 ref, append.

Descriptors: *Lake Ontario, *Canada, *Path of pollutants, *Model studies, Effluent models, Spills, Water currents, Wind, Drogues, Simulation analysis, Graphs.

The development of coastal effluent models of two locations on Lake Ontario, Pickering and the Niagara River are examined. The models employ microcomputers to simulate the entry into Lake Ontario of spills or effluent plumes at either site. A spill or plume is observed as it interacts with shore currents. Observations have indicated that the coastal currents are highly correlated with the alongshore wind component. A simple linear impulse response function is applied which relates current to wind history. The current response is calibrated by observing the behavior of drogues released in the river mouth for the Niagara River compared with wind measurement. Current measurements from fixed devices and daily wind observations have been used to derive the coefficients in the Pickering response function. Comparisons with drogued history for Niagara and water temperature distribution for Pickering have been used to assess the accuracy of the results, at least in a few interesting situations. Software enabling the user to work from existing wind observations or to operate in predictive mode by entering hypothetical wind data has been developed, and a number of display options for the plume or patch are offered. (Author's abstract)
W90-05044

STUDY ON SOLUTE NO₃-N TRANSPORT IN THE HYDROLOGIC RESPONSE BY AN MRF MODEL.

Trento Univ. (Italy). Dept. of Engineering.
A. Rinaldo, A. Bellin, and A. Marani.
Ecological Modelling ECOMODT, Vol. 48, No. 3/4, p. 159-191, November 1989. 16 fig, 21 ref.

Descriptors: *Path of pollutants, *Solute transport, *Nitrates, *Model studies, Sorption, Equilibrium, River basins, Residence time, Predictive models.

The results of field studies on solute transport over basin-scale distances are analyzed using the Mass-Response Function (MRF) model and its generalization proposed in this paper. The generalization proposed concerns reversible production/removal processes of solute. It is assumed that equilibrium concentrations in the mobile phase are proportional to the instantaneous fraction of solute mass sorbed in the fixed phase. Such an assumption, which is representative of large-scale transport volumes, is derived from the theory of two-component convection-dispersion in soils and is aimed at endowing the model with predictive characters. The conditionality of the transfer functions on the injection time is related in a rational manner to the combined effects of convection-dispersion during the hydrologic cycle and of sorption processes that occur between fixed and mobile phases. The relevance of the problem addressed lies in the ability of solute generation and movement over large scales to predict the dominant modes of the phenomena on the basis of the knowledge of parameters with a clear physical significance. The results show that a number of characteristic residence times are the most important properties for basin-scale transport processes and for the evolution of resident and flux solute concentrations. An MRF model of solute NO₃-N concentrations in river waters is constructed, the architecture of which is tailored to solute generation and transport processes occurring in a gaged watershed. The theoretical results are compared with the experimental observations and are found to agree with them. It is argued that MRFs are rational models of the complex chain of events occurring in large-scale solute sorption and transport, and may be validly employed for quantitative studies of environmental impacts due to the release of chemical species in surface or subsurface waters. (Author's abstract)
W90-05045

METHANOGENESIS IN SEDIMENTS OF THE POLLUTED LOWER REACHES OF THE TAMA RIVER.

Tokyo Metropolitan Univ. (Japan). Dept. of Biology.
S. Takii.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p. 235-246, 1989. 3 fig, 3 tab, 37 ref.

Descriptors: *Methanogenesis, *Japan, *Sediment chemistry, *Methane, *Water pollution effects, *Biodegradation, Seasonal variation, Sulfates, Interstitial water, Inhibition.

Seasonal changes of methanogenesis were studied in sediments of three stations along the water course in the polluted lower reaches of the Tama River, Japan. Methanogenesis was the highest at the upper freshwater station and decreased near the river mouth, in accordance with increasing concentration of sulfate in interstitial water. At all stations methanogenesis increased from spring to summer and decreased in winter except for once at the lowest station. The sediment layer which showed the highest activity tended to become deeper downstream. Effects of additions of substrates or inhibitors on methanogenesis in sediment slurries suggested that methanogenesis was competitively inhibited by sulfate reduction in sediments containing high sulfate concentrations, but the degree of the inhibition decreased in sediments with low sulfate concentration. (Author's abstract)
W90-05056

U.S. GEOLOGICAL SURVEY TOXIC SUBSTANCES HYDROLOGY PROGRAM: PROCEEDINGS OF THE TECHNICAL MEETING, PHOENIX, ARIZONA, SEPTEMBER 26-30, 1988.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4220, 1989. 651p. G. E. Mallard, and S. E. Ragone, editors.

Descriptors: *Groundwater pollution, *Water pollution, *Toxic wastes, *Path of pollutants, *Fate of pollutants, Hydrology, Nonpoint pollution sources, Research, Field tests, Laboratory methods.

New earth science information concerning the movement and fate of contaminants in the Nation's groundwater and surface water appears in 68 technical papers and 28 abstracts in proceedings of a September 1988 meeting on the U.S. Geological Survey's Toxic Substances Hydrology Program. The proceedings are organized into 10 chapters that focus on field-site investigations, nonpoint source research, or methods research. The 11th chapter contains abstracts and short papers on a variety of subjects presented as posters during the meeting. The proceedings present: (1) results of research, still in progress, on the occurrence and movement of hazardous substances within specific hydrologic systems; these intensive interdisciplinary investigations represent a key element of the research approach taken by the Toxic Substances Hydrology Program; (2) results of nonpoint source groundwater contamination research; the focus in these studies is more statistical and less deterministic than the intensive field studies because of the large number of natural and anthropogenic factors being studied and their spatial and temporal variation; and (3) research methods and techniques used to study toxic substances transport and fate, including both field and laboratory methods from the disciplines of chemistry, biology, biochemistry, geology, and physical hydrology. (See W90-05060 thru W90-05128) (Author's abstract)
W90-05059

SILICA MOBILITY IN A PETROLEUM-CONTAMINATED AQUIFER.

Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W90-05060

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: I. THE DISTRIBUTION OF CHEMICAL SPECIES AND GEOCHEMICAL FACIES.

Geological Survey, Reston, VA.
M. J. Baedeker, D. I. Siegel, P. Bennett, and I. M. Cozzarelli.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988.

Sources Of Pollution—Group 5B

988. USGS Water-Resources Investigations Report 88-4220, 1989. p 13-20, 3 fig, 1 tab, 12 ref.

Descriptors: *Oil pollution, *Groundwater pollution, *Biodegradation, *Water pollution effects, *Fate of pollutants, *Aquifers, *Minnesota, *Hydrocarbons, Methane, Iron, Manganese, Carbon, Organic matter.

Crude oil floating at the surface of a shallow aquifer of glacial outwash, near Bemidji, Minnesota, is altered by geochemical processes. Hydrocarbons from the oil are attenuated by several reactions that include aerobic and anaerobic microbial degradation. These degradation reactions result in the development of geochemical facies in the shallow groundwater system. Groundwater most affected by the presence of organic compounds is anoxic, and concentrations of methane, dissolved organic carbon, and total inorganic are high—0.76 millimole/L, 2.9 millimole/L, and 12.3 millimole/L, respectively. The concentrations of chemical species and delta-(13)C isotope values indicate that the plume near the oil lens has become progressively more reducing. Over a 4-year period (1984 through 1987), the concentrations of methane and iron have increased by a factor of > 25. The data suggest that sequential degradation occurs, as predicted by thermo-dynamics: manganese is reduced before iron is reduced, which occurs before methanogenesis. These data provide field evidence that reduction of iron and manganese is an important mechanism of decomposition of organic matter in aquifers. The delta-(13)C values of inorganic carbon of the native groundwater range from -12 ppt to -15 ppt as a result of mixing of soil CO₂ with CO₂ from the dissolution of carbonates. Non methanogenic biodegradation of oil constituents adds isotopically light CO₂ to the groundwater because the oil has a delta-(13)C value of 28 ppt. The delta-(13)C value of inorganic carbon in the reducing zone have become progressively heavier from 1985 through 1987. The maximum change occurs 15 m downgradient from the oil lens, where the delta-(13)C values increased from -21.6 ppt to -5.35 ppt. This change indicates that the plume has become more reducing and methanogenic over time. (See also W90-05059) (Author's abstract) W90-05061

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: II. EVIDENCE OF ANAEROBIC DEGRADATION OF MONOAROMATIC HYDROCARBONS.

Geological Survey, Reston, VA.
1 M. Cozzarelli, R. P. Eganhouse, and M. J. Baedeker.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 21-33, 5 fig, 2 tab, 22 ref.

Descriptors: *Oil pollution, *Fate of pollutants, *Water pollution effects, *Biodegradation, *Groundwater pollution, *Hydrocarbons, *Minnesota, Geochemistry, Organic carbon, Benzene, Anaerobic conditions, Methane, Carbon dioxide, Microbial degradation.

The presence and fate of dissolved monoaromatic hydrocarbons and low-molecular weight organic acids were investigated in groundwater downgradient from a subsurface crude oil spill in Bemidji, Minnesota. Degradation of soluble crude-oil components has resulted in the formation of a reducing geochemical environment characterized by increased concentrations of dissolved organic carbon, carbon dioxide, and methane, and the absence of oxygen. Benzene, Cl to C₄-alkyl-benzenes, and aliphatic, aromatic, and alicyclic organic acids were identified in anaerobic groundwater downgradient from the oil. Concentrations of the monoaromatic hydrocarbons and organic acids decrease rapidly, relative to the bulk of the dissolved organic carbon, with distance downgradient. Benzene and alkylbenzenes decrease from 8.5% to 4% of the dissolved organic carbon in 30 m from the edge of the oil lens, whereas low molecular weight organic acids decrease from 6.5% to less than 1%. Concentrations of some alkylbenzenes approach detection limits within the anaerobic plume. Individual monoaromatic hydrocarbons differ in the rates at which they are removed from the aquifer. The preferential removal of specific alkylbenzenes may reflect structure-dependent degradation rates. The highest concentrations of organic acids, CH₄ and CO₂ are in the anaerobic zone. The organic acids represent microbial intermediates that can be related to proposed methanogenic-degradation pathways. The presence of organic acids and phenols, and the generation of gases in the anaerobic groundwater support the conclusion that anaerobic degradation of aromatic hydrocarbons is an important geochemical process. (See also W90-05059) (Author's abstract) W90-05062

VARIABILITY IN THE CHEMISTRY OF NONVOLATILE ORGANIC ACIDS DOWNGRADIENT FROM THE OIL BODY AT BEMIDJI, MINNESOTA.

Geological Survey, Denver, CO.
G. R. Aiken, and K. A. Thorn.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 35-40, 2 fig, 1 tab, 11 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Oil pollution, *Groundwater pollution, *Minnesota, *Aquifers, Organic carbon, Hydrophobic acids, Fractionation analysis, Spectroscopy.

The distribution and chemistry of nonvolatile organic acids were studied in an aquifer contaminated with crude oil near Bemidji, Minnesota. For the six wells sampled during the summer of 1987, dissolved organic carbon concentrations ranged from a high value of 42 mg carbon/L for the well closest to the oil body, to a low value of 2.9 mg carbon/L for the uncontaminated groundwater. Dissolved organic carbon fractionation analyses indicated that the majority of the dissolved organic carbon in each sample was comprised of nonvolatile organic acids resulting from the microbiological degradation of the crude oil. Results of elemental analyses and molecular-weight determinations indicate that the hydrophobic acids from the contaminated well have higher carbon and hydrogen contents and lower oxygen and nitrogen contents, and much lower molecular weights (250 daltons) than the hydrophobic acids from the background well, reflecting differences in composition of original source materials for these samples. Analyses of the structural composition of the molecules comprising the hydrophobic-acid fractions by carbon-13 nuclear-magnetic resonance spectroscopy and infrared spectroscopy have demonstrated that the hydrophobic acid fractions isolated from the contaminated well have lesser amounts of carboxyl carbon and hetero-aliphatic carbon and greater amounts of aromatic carbon and aliphatic carbon than the sample from the background well. In addition, the solid state carbon-13 nuclear-magnetic resonance spectra suggest that there is little variation in the composition of the hydrophobic acids downgradient from the oil body and that aromatic and isoparaffinic components of the crude oil have been preserved in the form of carboxylic acids. (See also W90-05059) (Author's abstract) W90-05063

CHARACTERIZATION OF NONVOLATILE ORGANIC ACIDS RESULTING FROM THE BIODEGRADATION OF CRUDE OIL BY NUCLEAR MAGNETIC RESONANCE SPECTROMETRY.

Geological Survey, Denver, CO.
K. A. Thorn, and G. R. Aiken.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 41-51, 7 fig, 1 tab, 8 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Oil pollution, *Groundwater pollution, *Minnesota, Wells, Spectroscopy, Hydrophilic acids, Hydrophobic acids, Organic acids, Aromatic compounds.

Three fractions of nonvolatile organic acids resulting from the biodegradation of crude oil have been isolated from wells downgradient from the oil body at the Bemidji, Minnesota, site. The organic acids and the undergraded whole crude oil have been characterized by using carbon-13 nuclear magnetic resonance spectroscopy. Hydrophilic acids, hydrophobic acids, and the hydrophobic neutral fraction of organic acids were analyzed using quantitative and attached proton-test carbon-13 nuclear magnetic resonance. The crude oil was analyzed by quantitative and distortionless enhancement by polarization transfer carbon-13 resonance. The hydrophobic acids and hydrophobic neutral fraction were found to be enriched in aromatic carbons compared to the whole crude oil. All three fractions of organic acids appear to have been derived from the aromatic, branched chain, and cyclic components of the original crude oil. (See also W90-05059) (Author's abstract) W90-05064

DETERMINATION OF THE AIR-PHASE PERMEABILITY TENSOR OF AN UNSATURATED ZONE AT THE BEMIDJI, MINNESOTA, RESEARCH SITE.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 2F.

W90-05065

RESEARCH ON METALS IN ACID MINE DRAINAGE IN THE LEADVILLE, COLORADO, AREA.

Geological Survey, Denver, CO.
B. A. Kimball, K. E. Bencala, and D. M. McKnight.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 65-70, 3 fig, 13 ref.

Descriptors: *Path of pollutants, Geochemistry, *Water chemistry, *Acid mine drainage, *Heavy metals, *Stream pollution, *Colorado, *Solute transport, Distribution patterns, Chemical properties, Sediments, Ecological effects, Hydrologic properties.

Past mining of ore deposits in the Leadville, Colorado, area has yielded large quantities of valuable metals. Water flowing through abandoned tailings and from adits in this area currently (1988) contributes large quantities of cadmium, copper, iron, lead, manganese, nickel, and zinc to the Arkansas River. Reactive solute-transport processes that occur within the channel are not well quantified. An interdisciplinary study of controls on the transition metal concentrations in streams of the Leadville area is providing an improved understanding of the transport and removal mechanisms that control transition metal concentrations in streams in general. The objective of the study are to: (1) characterize the within-stream chemical processes that control the transport and distribution of transition metals in streams of the Leadville, Colorado, area; (2) characterize the chemistry of sediment and sediment coatings that are active in controlling the dissolved concentrations of trace metals; (3) quantify the time and length scales for chemical and hydrologic processes that affect the metals and the function of chemical equilibrium and kinetics; and (4) quantify the effect of metals on biota and the function of biota in controlling metal concentration. To accomplish these objectives, the project is defining the chemical reactions in the zone where natural conditions change to conditions affected by acid mine drainage. Sediments studies are seeking to determine the concentration, mineralogy, and chemistry of suspended and bed sediment including colloids. Hypotheses about controlling mechanisms will be tested with instream transport experiments. (See also W90-05059) (Author's abstract) W90-05066

INSTREAM CHEMICAL REACTIONS OF ACID MINE WATER ENTERING A NEUTRAL STREAM NEAR LEADVILLE, COLORADO.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

Geological Survey, Denver, CO.
B. A. Kimball, and G. A. Wetherbee.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 71-79, 7 fig, 2 tab, 7 ref.

Descriptors: *Acid mine drainage, *Geochemistry, *Path of pollutants, *Water chemistry, *Heavy metals, *Stream pollution, *Colorado, *Solute transport, Hydrogen ion concentration, Metal partitioning, Manganese, Cadmium, Zinc, Iron, Copper, Particulate matter.

Mixing of acid drainage from mines and mine tailings with neutral-pH streamwater affects the transport of metals in surface waters. In the Leadville, Colorado, area, California Gulch, a stream that contains drainage from many mines, enters the upper Arkansas River and flows into water with a higher pH. The effect of the higher pH on the partitioning of metals between the dissolved phase (less than 0.1 micrometer filtrate) and the suspended-sediment phase (greater than 0.1 micrometer particle size) was studied in two transects downstream from the inflow of California Gulch to the Arkansas River. Iron is totally partitioned to the suspended-sediment phase, whereas manganese remains totally in the dissolved phase. Iron is non-conservative or reactive, and manganese, cadmium, and zinc are conservative. Copper concentrations are near the detection limit, and it is difficult to distinguish between conservative and non-conservative transport because of the small variation in concentration. The quantity of each metal that is partitioned to the suspended-sediment phase can still be transported downstream, because the very small particle size of the suspended-sediment enables it to remain in suspension. (See also W90-05059) (Author's abstract)

W90-05067

HEAVY-METAL GEOCHEMISTRY OF SEDIMENTS IN THE PUEBLO RESERVOIR, COLORADO.

Geological Survey, Reston, VA.
E. Callender, W. H. Ficklin, B. A. Kimball, and P. R. Edelmann.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 81-91, 8 fig, 1 tab, 6 ref.

Descriptors: *Water chemistry, *Path of pollutants, *Geochemistry, *Acid mine drainage, *Heavy metals, *Sediment contamination, *Colorado, *Cores, Reservoir sediments, Titanium, Spatial distribution.

Three sediment cores, collected along the axis of Pueblo Reservoir in south-central Colorado, were analyzed for their heavy-metal content. The data were normalized with respect to titanium, an integral component of igneous and sedimentary rocks in the upper Arkansas River basin. The vertical distribution of normalized heavy-metal data shows some pronounced peaks at depths that record sedimentary riverine inputs during the past 10 years. A core near the river mouth shows normalized copper, zinc, lead, cadmium maxima at depths (14 and 26 centimeters) that correspond to metal discharges from the Leadville mines during 1985 and 1983. The other two cores, located farther from the riverine source, show a pronounced maxima at the 4-centimeter to 6-centimeter depth, indicative of contaminant inputs during 1985. Although the possibility exists that the metal distributions have been affected by sedimentary diagenesis, normalized metal data for riverine suspended sediment and lacustrine bottom sediment suggest that the bottom sediments in Pueblo Reservoir record a history of heavy-metal inputs by acid-mine drainage in the upper Arkansas River basin. (See also W90-05059) (Author's abstract)

W90-05068

METAL PARTITIONING AND PHOTOREDUCTION OF IRON IN FILTRATES OF ACID STREAMWATER, ST. KEVIN GULCH, LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
B. A. Kimball, and D. M. McKnight.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 93-100, 5 fig, 2 tab, 7 ref.

Descriptors: *Path of pollutants, *Water chemistry, *Geochemistry, *Acid mine drainage, *Iron, *Mountain streams, *Colorado, Photochemical reactions, Particulate matter, Light intensity.

Onsite experiments in high-altitude acidic mountain streams have indicated that photochemical reactions affect the chemistry of dissolved iron. Previous work defined the rates of daytime photoreduction and nighttime oxidation of iron species in St. Kevin Gulch near Leadville, Colorado, which receives acid mine drainage. This work evaluated the dependence of the photochemical reactions on the presence of stream particulate matter and bacteria in the stream, both of which might catalyze the reaction. The progress of photoreduction with increasing light intensity was monitored by colorimetric determination of ferrous and total iron concentrations in aliquots from an ultrafiltrate (from which bacteria and suspended particulate matter that might catalyze the photoreaction were removed; but smaller organic matter, such as enzymes, may still have been present), from a 0.1 micrometer filtrate and from an unfiltered sample. Concentrations of metals in the different filtrates were evaluated by a chemical-equilibrium model. The initial concentration of ferrous iron in each sample was about 0.2 mg/L; the concentration doubled in the ultrafiltrate, and increased about fourfold in the unfiltered sample. In each sample, the trend of the ferrous-to-total-iron ratio was the same, following the trend of light intensity. Although photoreduction proceeded in each sample, it proceeded to a greater extent where additional iron was available. (See also W90-05059) (Author's abstract)

W90-05069

PARTITIONING OF METALS BETWEEN WATER AND FLOCCULATED BED MATERIAL IN A STREAM CONTAMINATED BY ACID MINE DRAINAGE NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
K. S. Smith, D. L. Macalady, and P. H. Briggs.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 101-109, 9 fig, 7 ref.

Descriptors: *Acid mine drainage, *Stream pollution, *Mountain streams, *Water chemistry, *Geochemistry, *Path of pollutants, *Heavy metals, Hydrogen ion concentration, Iron, Aluminum, Zinc, Manganese, Copper, Cadmium, Solubility, Partitioning, Sorption, Flocculation.

Onsite metal-partitioning studies were performed in August 1987 using mixtures of flocculated iron oxyhydroxide material (floc) and stream-water collected from St. Kevin Gulch, a central Colorado mountain stream contaminated by acid mine drainage. The pH was varied between ambient (about 3.5) and 6 by the addition of NaHCO₃ to aliquots of unfiltered streamwater and floc/streamwater mixtures. Iron and aluminum aqueous concentrations seem to be controlled primarily by solubility reactions, whereas zinc, manganese, copper, and cadmium concentrations are controlled by sorption reactions. The sorption reactions are pH dependent, with a sorption edge between pH 5 and 6 for zinc, and between pH 3.5 and 4.5 for copper. Cadmium does not appear to have a well-defined sorption edge up to pH 6, and the manganese concentration gradually decreases over the pH range tested. Flocculated iron oxyhydroxide material does not seem to be an effective sink for trace metals in St. Kevin Gulch at the ambient pH of about 3.5. Although pH-dependent solubility and sorption reactions drive metal partitioning to the solid phase at higher pH, aqueous concentrations of manganese, zinc, and cadmium at pH 6 are still significant. (See also W90-05059) (Author's abstract)

W90-05070

COLLOIDAL PROPERTIES OF FLOCCULATED BED MATERIAL IN A STREAM CONTAMINATED BY ACID MINE DRAINAGE, ST. KEVIN GULCH, COLORADO.

Geological Survey, Denver, CO.
J. F. Ranville, K. S. Smith, D. L. Macalady, and T. F. Rees.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 111-118, 6 fig, 1 tab, 15 ref.

Descriptors: *Path of pollutants, *Water chemistry, *Acid mine drainage, *Stream pollution, *Heavy metals, *Iron, *Colorado, Flocculation, Aluminum, Zinc, Manganese, Lead, Copper, Cadmium, Electron microscopy, Electrophoretic mobility, Colloids.

A suite of samples of flocculated iron oxyhydroxide material (floc) was collected along St. Kevin Gulch, a central Colorado metal-rich stream (pH less than 3.8) contaminated by acid mine drainage. Iron is the predominant metal in the floc, with minor amounts of aluminum, zinc, and manganese, and trace amounts of lead, copper, and cadmium. Scanning electron microscopy reveals that the floc is composed of aggregates, generally greater than 1 micrometer in size, of uniformly sized 0.04 micrometer spheruloids. Large values of surface area, on the order of 150 sq m/g, were measured. Electrophoretic mobility measurements, made using a light-scattering technique, indicated a near-neutral charge in the shear plane. Formation of these flocs from iron oxyhydroxide colloids in the stream is consistent with the near-zero charge implied by their electrophoretic mobility. The mechanism(s) of formation of these apparently monodisperse colloids, the physical chemistry responsible for the surface charge neutralization, and the importance of the floc aggregates in metal partitioning in St. Kevin Gulch are under investigation. (See also W90-05059) (Author's abstract)

W90-05071

PRELIMINARY ASSESSMENT OF THE EFFECTS OF ACID MINE DRAINAGE ON GROUND WATER BENEATH A WETLAND NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
K. Walton-Day, and P. H. Briggs.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989.
988. USGS Water-Resources Investigations Report 88-4220, 1989. p 119-124, 3 fig, 1 tab, 10 ref.

Descriptors: *Acid mine drainage, *Water pollution effects, *Path of pollutants, *Water chemistry, *Stream pollution, *Groundwater pollution, *Colorado, Calcium sulfate, Wetlands, Manganese, Sulfides.

St. Kevin Gulch, located west of Leadville, Colorado, is a stream that is affected by acid mine drainage; it drains to the east into a wetland before entering Tennessee Creek and the East Fork of the Arkansas River. Surface-water and groundwater samples were collected from the wetland area to allow characterization of the water samples and to determine if groundwater has been affected by acid mine drainage. Analyses of the water samples showed that most of the water is a calcium sulfate type, indicating the presence of sulfide mineralization in the study area. Groundwater samples that may have been affected by acid mine drainage are relatively oxidized, contain elevated concentrations of manganese and sulfate relative to other samples, and were collected from the western side of the study area near known areas of mineralization. (See also W90-05059) (Author's abstract)

W90-05072

HYDROXYL RADICAL FORMATION IN ST. KEVIN GULCH, AN IRON-RICH STREAM IN COLORADO.

Sources Of Pollution—Group 5B

Geological Survey, Denver, CO.

A. C. Sigleo, K. M. Cunningham, M. C. Goldberg, and B. A. Kimball.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 125-129, 3 fig, 1 tab, 10 ref.

Descriptors: *Acid mine drainage, *Path of pollutants, *Water pollution sources, *Water chemistry, *Iron, *Stream pollution, *Colorado, *Hydroxyl radicals, Colloids, Dissolved iron, Photolytic reduction, Leachates.

Water samples were collected from St. Kevin Gulch, a tributary of Tennessee Creek and the Arkansas River, Colorado. This stream is affected by acid leachates from mine tailings and contains large concentrations of ferric iron that may provide a reactant for the photolytic production of hydroxyl radicals. Water samples were irradiated in a photoreactor with an average incident ultraviolet (300-400 nanometers) photon flux of 0.00045 Einsteins/min. Samples containing an iron concentration of 0.03 mg/L had a steady-state hydroxyl radical concentration of 4×10^{-10} to the minus 15 moles/L, whereas water containing 11 mg/L iron had a steady-state hydroxyl radical concentration of 2×10^{-10} to the minus 13 moles/L, which is unusually large for a natural water sample. The relation between steady-state hydroxyl radical concentration and total dissolved and colloidal iron concentration appears to be linear. These results may indicate that photolytic reduction of ferric iron is a major source of hydroxyl radicals in this stream. (See also W90-05059) (Author's abstract) W90-05073

OVERVIEW OF CONTAMINANT HYDROLOGY, GEOCHEMISTRY, AND MICROBIOLOGY AT THE CAPE COD TOXIC WASTE RESEARCH SITE.

Geological Survey, Marlborough, MA.

S. P. Garabedian, and D. R. LeBlanc.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 133-142, 3 fig, 1 tab, 25 ref.

Descriptors: *Water chemistry, *Geochemistry, *Toxic wastes, *Hazardous waste disposal, *Massachusetts, *Waste dumps, *Path of pollutants, *Fate of pollutants, *Groundwater pollution, Hydrology, Microbiology, Chemical analysis, Volatile organic compounds, Tracers, Solute dispersion, Hydraulic conductivity.

An overview of past and current research on contaminant hydrology, geochemistry, and microbiology is presented for the Cape Cod Toxic Waste Research site. Groundwater recharge to the study area occurs primarily from precipitation and underflow from upgradient areas. Little surface-water runoff occurs because the sandy soils are very permeable. Past research efforts have focused on the definition and description of the extent of contaminants in a sewage plume originating from the Otis Air Base sewage treatment facility. The plume of sewage-contaminated groundwater is characterized by elevated concentrations of dissolved solids, boron, chloride, sodium, phosphorus, ammonium, nitrate, and detergents, and in some locations, volatile organic compounds (VOC). Current research at the site includes efforts to use tracer tests and other in situ measurement techniques to quantify the processes affecting the fate and transport of sewage contaminants in the aquifer. A major research thrust at this site has been to relate the dispersion of solutes to the heterogeneity of aquifer hydraulic properties. In particular, it has been found that dispersion of solutes in aquifers is strongly affected by variation in hydraulic conductivity. Other current research topics include an examination of the sediments to determine the primary control of adsorption of organic compounds in the aquifer. (See also W90-05059) (White-Reimer-PTT) W90-05074

SIMULATION OF THE RATE-CONTROLLED TRANSPORT OF MOLYBDATE IN COLUMN EXPERIMENTS.

Geological Survey, Denver, CO.

K. G. Stollenwerk, and K. L. Kipp.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 151-161, 5 fig, 2 tab, 10 ref.

Descriptors: *Path of pollutants, *Water chemistry, *Geochemistry, *Geohydrology, *Groundwater chemistry, *Molybdates, *Solute transport, *Model studies, Sorption, Diffusion, Equilibrium, Aquifers, Massachusetts.

Laboratory column experiments were used to identify potential rate-controlling mechanisms that could affect transport of molybdate in the natural-gradient tracer test done at Cape Cod, Massachusetts. Column breakthrough curves for molybdate were simulated by using a one-dimensional solute-transport model that was modified to include four different rate mechanisms: equilibrium sorption, rate-controlled sorption, and two side-pore diffusion models. One side-pore diffusion model was based on an average side-pore concentration of molybdate (mixed side-pore diffusion); the other was based on a concentration profile for the overall side-pore depth (profile side-pore diffusion). The equilibrium model failed to simulate the experimental data, indicating the presence of a rate-controlling mechanism. The rate-controlled sorption model simulated results from one column reasonably well, but could not be applied to other columns that had different input concentrations without changing the rate constant. The mixed side-pore diffusion model also resulted in reasonable correlation with experimental data, and the parameters applied to a variety of input concentrations. The most accurate simulations for the largest variety of input concentrations were achieved by using the profile side-pore diffusion model. (See also W90-05059) (Author's abstract) W90-05076

SOLUTE DIFFUSION WITHIN SAND OF THE CAPE COD, MASSACHUSETTS, AQUIFER.

Geological Survey, Reston, VA.

W. W. Wood, P. P. Hearn, and T. F. Kraemer.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 163-166, 2 fig.

Descriptors: *Path of pollutants, *Water chemistry, *Cape Cod, *Solute transport, *Aquifers, *Groundwater chemistry, Tracers, Electron microscopy, Cation exchange, Massachusetts, Matrix diffusion.

Laboratory experiments have suggested that matrix diffusion is a major mechanism controlling cation transport in groundwater of the Cape Cod, Massachusetts, aquifer. Experiments using radiotopes, in combination with differential leaching and air abrasion techniques demonstrate that cations penetrate into the interior of mineral grains. Scanning-electron microscopy and X-ray analysis of material in the interiors of the feldspars and biotite confirm the presence of authigenic clays in the interiors of the grains. These internal clays are believed to act as cation-exchange sites for the intruding cations. Mercury-porosimetry studies support the presence of significant internal porosity of all the mineral grains examined in this study. The data indicate that diffusion into grain interiors is a major mechanism controlling the concentration of cations in the system and these mechanisms must be considered in solute transport simulations in certain clastic aquifers. Due to the nonequilibrium diffusion nature of transport in the system, a conservative ion may not be a good indicator of hydrodynamic dispersion exhibited by a reacting ion. (See also W90-05059) (Author's abstract) W90-05077

USE OF TRACER TESTS TO MEASURE THE TRANSPORT AND CONSUMPTION OF METHANE IN A CONTAMINATED AQUIFER.

Geological Survey, Denver, CO.

R. L. Smith, B. L. Howes, and J. H. Duff.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 167-175, 4 fig, 35 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Tracers, *Biodegradation, *Methane, *Groundwater pollution, *Aquifers, *Nitrates, Massachusetts, Carbon radioisotopes, Oxidation, Sand, Gravel, Halides, Denitrification, Water depth, Cape Cod.

Rates of methane oxidation were measured in a nitrate-enriched zone of an unconfined sand and gravel aquifer (Cape Cod, Massachusetts) using in situ natural-gradient tracer tests. Methane oxidation was calculated from breakthrough curves of methane relative to halide and inert gas (hexafluoroethane) tracers and confirmed by the appearance of ^{13}C -enriched carbon dioxide in experiments with ^{13}C -enriched methane as the tracer. Methane oxidation predominantly occurred in a zone of denitrification; the highest rates of methane oxidation and denitrification were found at the same depth. These results indicate that nitrate may be a possible electron acceptor for methane oxidation in groundwater systems. (See also W90-05059) (Author's abstract) W90-05078

INFLUENCE OF GEOCHEMICAL HETEROGENEITY IN A SAND AND GRAVEL AQUIFER ON THE SORPTION OF CHLOROBENZENES.

Geological Survey, Denver, CO.

L. B. Barber.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 177-182, 1 fig, 4 tab, 12 ref.

Descriptors: *Chlorinated hydrocarbons, *Path of pollutants, *Sorption, *Geochemistry, *Humic substances, *Benzenes, *Solute transport, *Groundwater pollution, Chlorobenzenes, Model studies, Simulation analysis.

The partitioning of nonionic-organic solutes between the aqueous and sediment phases within an aquifer is a function of the organic-carbon content of the sediment. It is proposed that naturally occurring organic compounds (humic substances) preferentially associate with iron-oxide coated mineral surfaces as the result of charge interactions. The resulting carbon-enriched iron oxide surfaces should be a more effective sorbent than the bulk sediment. A numerical simulation is presented that demonstrates the potential effect of sediment-organic carbon association with a particular mineral phase. A one-dimensional solute-transport model, coupled with partition theory and the measured organic-carbon content of particle-size and mineralogical fractions from the Cape Cod (Massachusetts) Toxic Waste Research site, is used to simulate the sediment geochemical effect on the subsurface transport of a series of chlorinated benzene compounds. (See also W90-05059) (Author's abstract) W90-05079

TRANSPORT OF BACTERIA IN A CONTAMINATED AQUIFER.

Geological Survey, Menlo Park, CA.

R. W. Harvey.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. 183-188, 3 tab, 12 ref.

Descriptors: *Path of pollutants, *Bacteria, *Groundwater pollution, *Pathogenic bacteria, Organic matter, Sediment transport, Model studies, Particle size, Massachusetts, Aquifers, Cape Cod.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

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The transport of bacteria through contaminated aquifers is becoming an increasingly important issue in public health and waste management. Many factors involved in the transport of bacteria through groundwater are poorly understood and there is a scarcity of field data. Two factors were evaluated: (1) the importance of colloid filtration theory as a determinant of the extent of transport and the size distribution of transported bacteria; and (2) the role of secondary pore structure in observed transport characteristics. Experiments were conducted at a small-scale, natural-gradient groundwater injection site in an area of organically contaminated groundwater (Cape Cod, Massachusetts) and in the laboratory by use of flow-through columns packed with aquifer sediments. Results from these experiments indicate that secondary pore structure relating to the manner in which the aquifer sediment particles are spatially arranged has a substantial effect on transport characteristics of bacteria-sized particles. Also, a modified dispersion-corrected, colloid-filtration model may be used to predict bacterial immobilization at particle surfaces and changes in bacterial size distribution that occurs with transport downgradient through aquifer sediments of Cape Cod. (See also W90-05059) (Author's abstract)
W90-05080

FIELD AND LABORATORY STUDIES OF COUPLED FLOW AND CHEMICAL REACTIONS IN THE GROUND-WATER ENVIRONMENT.

Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W90-05081

OVERVIEW OF RESEARCH ACTIVITIES ON THE CHEYENNE RIVER SYSTEM, WESTERN SOUTH DAKOTA.

Geological Survey, Rapid City, SD.
K. E. Goddard.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989, p 199-203, 1 fig, 10 ref.

Descriptors: *Mine drainage, *Arsenic, *Geochemistry, *Path of pollutants, *South Dakota, *Cheyenne River, Sediment transport, Stream pollution, Alluvial deposits, Sorption, Trace metals, Lotic environment.

In April 1985, the Whitewood Creek-Belle Fourche River-Cheyenne River-Lake Oahe surface-water system in western South Dakota was selected for investigation as part of the U.S. Geological Survey Toxic Substances in Surface-Water and Sediments Thrust program. Alluvial flood-plain sediments in this system contain arsenic and other trace metals derived from the 100 million metric tons of gold-mill tailings that were discharged into Whitewood-Creek between 1876-1977. Research activities include (1) sediment studies of the distribution, transport rate, and ultimate fate of arsenic and other trace metals sediments; (2) geochemical studies of trace metal partitioning between various solid phases and between solid and dissolved phases; and (3) biologic investigations of the effect of arsenic and other trace metals on the stream ecosystem. Preliminary findings indicate that arsenic is widely distributed in alluvial sediments and is being actively transported on suspended sediment. Total arsenic concentrations range from 300 to 5,000 micrograms/g in flood-plain sediment, 20 to 960 micrograms/g in suspended-sediment, and 20 to 260 micrograms/g in Lake Oahe sediments. Although as much as 50% of the total arsenic mass is in the form of arsenopyrite, adsorption-desorption of arsenic from ferric oxyhydroxides is the dominant process controlling dissolved-phase concentration. (See also W90-05059) (Author's abstract)
W90-05082

ARSENIC IN THE ALLUVIAL SEDIMENTS OF WHITEWOOD CREEK AND THE BELLE FOURCHE AND CHEYENNE RIVERS IN WESTERN SOUTH DAKOTA.

Geological Survey, Rapid City, SD.

T. E. McCallip, K. E. Goddard, and A. J. Horowitz.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989, p 203-209, 1 fig, 2 tab, 7 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Mine drainage, *Arsenic, *South Dakota, *Sediment transport, Alluvial deposits, Flood plains, Stream channels, Iron, Cheyenne River.

Large volumes of arsenopyrite-bearing tailings discharged over a 100-year period from gold mines near Lead, South Dakota, have accumulated as arsenic-rich contaminated sediment in the flood plains and channels of Whitewood Creek and the Belle Fourche and Cheyenne Rivers in western South Dakota. Extensive oxidation of arsenic-rich contaminated sediments is visually evident. The heavy-mineral fractions of contaminated sediments were isolated by using a bromoform flotation coupled with centrifugation. Percentages of heavy minerals ranged from 0.8 to 6.9 in channel sediments and from 14 to 56 in flood-plain sediments. Concentrations of arsenic ranged from 25 to 990 micrograms/g in suspended and bottom sediments and from 830 to 5,000 micrograms/g in flood-plain sediments. Percentages of heavy minerals and concentrations of arsenic and iron are smaller in suspended and bottom-sediment samples than in flood-plain samples. This indicates a recent change in the source of part of the sediment for the Cheyenne River system. (See also W90-05059) (Author's abstract)
W90-05083

TRENDS IN ARSENIC CONCENTRATION AND GRAIN-SIZE DISTRIBUTION OF METAL-CONTAMINATED OVERBANK SEDIMENTS ALONG THE BELLE FOURCHE RIVER DOWNSTREAM FROM WHITEWOOD CREEK, SOUTH DAKOTA.

Geological Survey, Indianapolis, IN.
D. C. Marron.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989, p 211-216, 2 fig, 1 tab, 8 ref.

Descriptors: *Mine drainage, *Arsenic, *Sediment contamination, *Path of pollutants, *Water pollution sources, *Belle Fourche River, *South Dakota, Sediment transport, Particle size, Wastewater disposal, Carbonates.

Arsenic-contaminated overbank deposits along the Belle Fourche River in west-central South Dakota resulted from the discharge of a large volume of mine tailings into Whitewood Creek between the late 1800's and 1977. The arsenic-contaminated overbank deposits are typically less than 2 m thick and extended about 90 meters away from the channel along the insides of meander bends. Carbonate minerals in the contaminated sediments limit desorption of arsenic by preventing acid formation. Within the contaminated overbank deposits along the Belle Fourche River, average arsenic concentrations decrease by a factor of three, and grain-size distributions become finer in a downstream direction. These changes only occur along channel reaches that receive significant inflow from tributaries draining shale-bedrock watersheds and appear to be caused by the dilution of mine tailings by uncontaminated sediment with a relatively finer grain-size distribution. An influx at high flow of uncontaminated sediment from terraces and the premining flood plain as well as from tributaries causes arsenic concentrations in parts of the contaminated deposit that are farthest away from the channel to be two to three times less than arsenic concentrations in overbank sediment that is immediately adjacent to the channel. (See also W90-05059) (Author's abstract)
W90-05084

ARSENIC GEOCHEMISTRY OF RAPIDLY ACCUMULATING SEDIMENTS, LAKE OAHE, SOUTH DAKOTA.

Geological Survey, Denver, CO.

W. H. Ficklin, and E. Callender.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989, p 217-222, 5 fig, 6 ref.

Descriptors: *Arsenic, *Geochemistry, *Water chemistry, *Lake sediments, *South Dakota, *Lake Oahe, Sediments, Color, Interstitial water, Sulfur bacteria, Sulfur.

Three sediment cores, collected from rapidly accumulating sediments in the Cheyenne River area of Lake Oahe, were analyzed for arsenic species from interstitial water and solid-sediment. In general, arsenic (V) was the predominant species in the surficial, oxidized sediments. In deeper, more reducing sediments, interstitial arsenic (III) is the dominant species. Solid-phase arsenic species distributions show approximately equal amounts of arsenic (III) and arsenic (V). In those sediment sections that exhibit a dark gray to black color, the solid-phase arsenic distribution is dominated by arsenic (III) and a residual arsenic phase that probably contains sulfide. Interstitial-water chemistry and solid-phase sulfur data indicate that these sediment intervals contain iron- and arsenic-sulfur phases that probably formed authigenically in response to the production of sulfide by microbial sulfate reduction. (See also W90-05059) (Author's abstract)
W90-05085

SOURCE AND TRANSPORT OF ARSENIC IN THE WHITEWOOD CREEK-BELLE FOURCHE-CHEYENNE RIVER-LAKE OAHE SYSTEM, SOUTH DAKOTA.

Geological Survey, Doraville, GA. Water Resources Div.

A. J. Horowitz, K. A. Elrick, and R. B. Cook.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989, p 223-233, 5 fig, 1 tab, 9 ref.

Descriptors: *Mine drainage, *South Dakota, *Arsenic, *Sediment contamination, *Water pollution sources, *Path of pollutants, Cheyenne River, Lake Oahe, Flood plains, Particle size, Suspended sediments, Arsenopyrite, Iron, Oxidation.

From 1875 through 1977, mining, milling, and processing wastes containing quantities of arsenopyrite were produced around Lead, South Dakota. Much of this material was discharged into Whitewood Creek. From there, parts of the waste were transported to the Belle Fourche River, thence to the Cheyenne River, and finally to the Missouri River. In 1958, the Missouri River was dammed at Pierre, forming Lake Oahe. Cores collected in the lake bottom show the presence of arsenic-rich layers in the bed sediments; the arsenic-rich layers in the bed sediments; the arsenic was attributed to arsenopyrite in the 8-to-16 and 16-to-32 micrometer size fractions of the sediments. Suspended-sediment samples collected in the Cheyenne River above Lake Oahe contained detectable quantities of both arsenopyrite and octahedral pyrite in the 8-to-16 and 16-to-32-micrometer fractions. Solid material collected from the banks and flood plains of the Belle Fourche River and Whitewood Creek contain reduced and oxidized phases. The reduced phases have an arsenic maxima in the 16-to-32 and the 32-to-63-micrometer size ranges. These fractions also contribute the most arsenic to the samples; the major source of arsenic seems to be arsenopyrite. The oxidized segments have an arsenic maxima in the less-than 2-micrometer size range. The less-than 2-micrometer maxima is associated with widely disseminated arsenic-bearing iron oxide coatings. The greater-than 63-micrometer fractions contribute the most arsenic to the oxidized samples; this arsenic, as in the reduced samples, is associated with arsenopyrite. These deposits probably are the source for the

arsenic-rich suspended sediments from the Bell Fourche River and for the arsenopyrite found in the bed sediments of Lake Oahe. (See also W90-05059) (Author's abstract)
W90-05086

COUPLED CHEMICAL, BIOLOGICAL AND PHYSICAL PROCESSES IN WHITEWOOD CREEK, SOUTH DAKOTA: EVALUATION OF THE CONTROLS OF DISSOLVED ARSENIC.
Geological Survey, Menlo Park, CA.
C. C. Fuller, J. A. Davis, G. W. Zellwegger, and K. E. Goddard.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 235-246, 6 fig, 1 tab, 22 ref.

Descriptors: *Path of pollutants, *Water chemistry, *Geochemistry, *Arsenic, *Iron, *Mine drainage, *South Dakota, *Photosynthesis, *Hydrogen ion concentration, *Adsorption, *Precipitation, *Equilibrium kinetics.

Coupled physical, chemical, and biological processes affect the concentration of dissolved arsenic in Whitewood Creek, South Dakota. In August 1987, dissolved arsenic concentrations were controlled primarily by adsorption and co-precipitation with iron oxyhydroxides (ferrihydrite) as groundwater enriched in arsenic entered the stream. Periphyton photosynthesis induced a diurnal pH fluctuation in streamwater of 0.25 to 0.5 pH units and a concomitant diurnal cycle in arsenate (30 to 40 percent variation). The fluctuation in arsenate reflects the dynamic equilibrium of adsorption-desorption processes occurring in response to the pH cycle. Kinetics of the sorption processes are slow, and result in a cycle of dissolved arsenic that lags several hours behind the pH cycle. Thus, the dynamic equilibrium of the chemical processes are tightly coupled to the biological processes occurring in the stream. (See also W90-05059) (Author's abstract)
W90-05087

PERIPHYTON EFFECTS ON ARSENIC TRANSPORT IN WHITEWOOD CREEK, SOUTH DAKOTA.

Geological Survey, Menlo Park, CA.
J. S. Kuwabara, C. C. Y. Chang, and S. P. Pasilis.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 247-255, 1 fig, 3 tab, 12 ref.

Descriptors: *Path of pollutants, *Water chemistry, *Periphyton, *Mine drainage, *Algae, *Biosay, *Arsenic, *Diatoms, *Culturing techniques, *South Dakota, *Seasonal variation, *Phosphates, *Bioaccumulation, *Arsenic compounds.

Increased periphyton abundance in Whitewood Creek, South Dakota, during the summer months suggests that chemical interactions involving arsenic and phosphorus between biota and the overlying water may significantly affect As transport and distribution in this mining-affected stream. Data used to predict arsenic transport for algae (for example, first-order uptake-rate constants, standing crop and accumulation factors) collected in the creek from upstream of mine discharges through a 57 kilometer affected reach have been determined. Cultures of *Achnanthes minutissima* (Bacillariophyceae) were isolated from four sites along a longitudinal gradient of dissolved arsenic within the study reach and then maintained at ambient dissolved arsenic concentrations. Arsenic uptake-rate constants for these isolates were determined as a function of dissolved arsenate and orthophosphate. All isolates appeared to have some exclusion mechanism by which phosphate was preferentially taken up over arsenate or by which excessive cell-associated arsenic was released. Initial uptake of both arsenate and orthophosphate appear to follow first order kinetics closely. Although uptake-rate constants increased slightly with increased dissolved arsenate concentrations, algae isolated from a site with elevated dissolved

arsenic showed a significantly slower arsenic uptake relative to the same species isolated from the least contaminated site upstream. Over a 4-month samples period during the summer of 1987, periphyton abundance increased downstream, then abruptly decreased at the site farthest downstream. Dissolved arsenic temperature, physical substrate, and turbidity may explain these trends in periphyton standing crop. (See also W90-05059) (Author's abstract)
W90-05088

TEMPORAL AND SPATIAL VARIABILITY OF ARSENIC IN BENTHIC INSECTS FROM WHITEWOOD CREEK, SOUTH DAKOTA.

D. J. Cain, S. V. Fend, and J. L. Carter.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 257-267, 2 fig, 5 tab, 11 ref, append.

Descriptors: *Path of pollutants, *Pollutant identification, *Bioindicators, *Mine drainage, *Arsenic, *South Dakota, *Aquatic insects, *Caddisflies, *Benthos, *Bioaccumulation, *Trophic level, *Hydropsyche, *Baetis, *Sediment contamination.

Whole body concentrations of arsenic were determined for benthic insects in Whitewood Creek, a stream contaminated with arsenic-bearing tailings from mining operations near its headwaters. Insects were collected in late May through early June of 1986 and 1987. Arsenic concentrations in insects appeared greater in 1987 than in 1986 at a station in the lower reach of the stream, but not at a station directly below the mine. Small differences in arsenic concentration between years also were evident in some taxa at a station above the mine. Although substantial differences in arsenic concentrations among taxa within stations were apparent, arsenic in all taxa collected from the contaminating reach was greater than in taxa from uncontaminated stations. Arsenic in *Hydropsyche* spp. and *Baetis tricaudatus* generally reflected the total arsenic concentrations of sediments. Trophic level and size appeared to be important variables affecting arsenic concentrations in insects. Results of experiments where insects were transferred from uncontaminated stations to a contaminated station showed that arsenic accumulation in herbivores and omnivores was more rapid than in predators. However, data indicate that nonspecific sorption of arsenic to the exoskeleton also contributed substantially to the total arsenic body burden. (See also W90-05059) (Author's abstract)
W90-05089

FATE AND TRANSPORT OF ORGANIC COMPOUNDS AND TRACE ELEMENTS IN THE LOWER CALCASIEU RIVER, LOUISIANA.

Geological Survey, Baton Rouge, LA.
C. R. Demas, and D. K. Demcheck.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 271-281, 3 fig, 5 tab, 10 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Louisiana, *Stream pollution, *Organic pollutants, *Trace elements, *Halogenated compounds, *Iron, *Manganese, *Mercury, *Chromium, *Salinity, *Sediment contamination, *Wind velocity, *Density.

A field study was initiated in 1985 by the U.S. Geological Survey to determine processes that control the fate and transport of manmade organic compounds and trace elements in the industrial reach and in the transition zone between brackish and freshwater of the lower Calcasieu River. Volatile and halogenated organic compounds, and four trace elements (iron, manganese, mercury, and chromium) were selected for study of the basis of results of reconnaissance sampling. Both classes of organic compounds and the four trace elements were determined to move in distinctly different ways in the aquatic environment and were either dissolved in the water column, associated with suspended sediment, or attached to bottom materi-

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al. Concentrations of volatile organic compounds in the lower Calcasieu River were found to depend on wind speed and density. Longitudinal movement of volatile organic compounds in the river was affected by the presence of salinity gradients, which restricted vertical mixing in the water column and provided, in one instance, a means of upstream transport from their source. Halogenated organic compounds, in contrast, were associated primarily with the bottom material which serves as a sink for these compounds because of their low solubility in brackish water. (Author's abstract)
W90-05090

REMOBILIZATION OF ORGANIC COMPOUNDS FROM BOTTOM MATERIAL COLLECTED FROM BAYOU D'INDE, LOUISIANA, UPON EXPOSURE TO DIFFERING IONIC-STRENGTH WATERS.

Geological Survey, Baton Rouge, LA.
C. R. Demas, and D. K. Demcheck.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 283-290, 1 fig, 4 tab, 8 ref.

Descriptors: *Sediment contamination, *Organic pollutants, *Water chemistry, *Geochemistry, *Path of pollutants, *Sediment-water interfaces, *Louisiana, *Elutriate tests, *Salinity, *Chlorobenzenes, *Chlorobutadiene, *Water column.

Bayou d'Inde, a small tributary of the lower Calcasieu River in southwestern Louisiana, has a heavy organic contaminant load in its bottom material. In April 1987, the U.S. Geological Survey conducted a series of experiments to determine under what conditions movement of these organic compounds from Bayou d'Inde bottom material into the water column would occur. Bottom material from Bayou d'Inde near industrial outfall canal, brackish water from Bayou d'Inde freshwater from the Calcasieu River near Kinder, Louisiana, and deionized water were analyzed for acid-base/neutral organic compounds. Results showed high concentrations, in the mg/kg range of chlorinated compounds in the bottom material and below levels of detection in the water samples. Modified elutriate tests were then performed on the bottom material and water. Tests indicated that mixing bottom material with brackish water from Bayou d'Inde resulted in no remobilization of organic compounds into the water column. Mixing bottom material with low ionic-strength waters, represented by Calcasieu River water near Kinder and deionized water, however, resulted in the remobilization of 1,2-dichlorobenzene and hexachlorobutadiene into the water at concentrations of 7 and 15 micrograms/L, respectively. On the basis of these results, potential environmental repercussions could occur if dredging of contaminated bottom material took place during periods of freshwater inflow. (Author's abstract)
W90-05091

USE OF RADON-222 AS A TRACER OF TRANSPORT ACROSS THE BED SEDIMENT-WATER INTERFACE IN PRIEN LAKE, LOUISIANA.

Geological Survey, Baton Rouge, LA.
C. R. Demas, P. B. Curwick, and D. K. Demcheck.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 291-300, 4 fig, 3 tab, 7 ref.

Descriptors: *Radon, *Path of pollutants, *Tracers, *Sediment-water interfaces, *Louisiana, *Cores, *Diffusion, *Lake sediments, *Radioisotopes.

Data from flux-chamber studies (December 1987 through February 1988) and analysis of core samples from Prien Lake, Louisiana, indicate a net movement of radon-222 from the bed sediment to the overlying water column. Apparent diffusion coefficients calculated from core and flux measurements exceeded the calculated molecular diffusion

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coefficient by two to seven times. Results indicate that factors, such as physical diffusion, stirring of the bed sediments, and increased water movement from the bed caused by wind-magnified tides and bubbling of gases such as methane from the bed sediment, may accentuate the movement of radon from the bed sediment to the overlying water column. The movement of radon-222 from the bed sediments to the overlying water column indicates that mechanisms exist for the movement of organic compounds and trace elements present in the interstitial pore water to the overlying water column. (Author's abstract)
W90-05092

PHASE ASSOCIATION OF TRACE METALS IN SEDIMENTS FROM THE CALCASIEU RIVER, LOUISIANA.

Geological Survey, Reston, VA.

N. S. Simon.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 301-308, 1 fig, 3 tab, 8 ref.

Descriptors: *Trace metals, *Chromium, *Sediment-water interfaces, *Path of pollutants, *Water chemistry, *Geochemistry, *Louisiana, Iron oxides, Manganese oxides, Organic matter, Cores, Organic carbon, Nitrogen, Extraction processes.

Statistical evaluation of data from a detailed study of extraction techniques for sediments has resulted in the identification of four mechanisms for retention of chromium by bottom sediments in the Calcasieu River, Louisiana. Chromium is partitioned in iron-oxide phases, manganese-oxide phases, labile organic matter, and refractory organic matter. Chromium retained by sediment in cores collected either upstream or downstream from petrochemical plant outfalls is associated with iron oxides and with organic matter subject to degradative reactions. In sediment taken from two sites close to petrochemical discharge, manganese oxides and refractory organic matter played major roles in the retention of chromium by sediment solids. These conclusions were based on sediment organic-carbon and nitrogen data, sediment total metal-concentration data, surface-adsorption studies, data from extractions with pyrophosphate-plus-hydrogen peroxide or hydrogen peroxide-plus-dilute hydrochloric acid, and interstitial-water metal analysis. The data indicate that the difference between chromium retention by metal oxides or organic matter could be inferred by using only the extraction data and the sediment organic-carbon and nitrogen data. Identification of metal phase association is a factor in determining metal bioavailability and mobility. Organically bound chromium could be mobilized in either oxic or anoxic environments or, possibly, under acidic conditions. Chromium associated with metal oxides could be mobilized in reducing or acidic conditions. (Author's abstract)
W90-05093

UPTAKE OF MANMADE ORGANIC COMPOUNDS BY RANGIA CUNEATA IN THE LOWER CALCASIEU RIVER, LOUISIANA.

Geological Survey, Baton Rouge, LA.

C. R. Demas, and D. K. Demas.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 309-319, 1 fig, 5 tab, 10 ref.

Descriptors: *Organic pollutants, *Mollusks, *Clams, *Bioassay, *Louisiana, *Path of pollutants, *Bioaccumulation, Toxicity, Bromoform, Chloroform, Dichloroethane, Chlorobenzenes, Chlorobutadiene.

Rangia cuneata, a brackish-water clam, was collected from an area of Lake Charles, Louisiana, unaffected by manmade organic compounds and placed in cages at two sites in the lower Calcasieu River affected by these compounds and at one recovery site downstream from the affected area in July and August 1987. Analyses of water and

bottom material for volatile organic compounds and acid-base/neutral extractable organic compounds indicated that no chemical contamination of the Lake Charles area has occurred. Elevated concentrations of bromoform, chloroform, and 1,2-dichloroethane in water and hexachlorobenzene and hexachlorobutadiene in bottom material were found at the affected sites in the lower Calcasieu River. Low or undetectable concentrations of organic compounds were present at the recovery site. Little or no uptake of organic compounds by Rangia cuneata occurred at the Lake Charles site. Complete mortality of Rangia cuneata occurred at the site on the Lower Calcasieu River where the most extensive contamination occurred (probably because of elevated water temperatures). Significant uptake of bromoform, chloroform, 1,2-dichloroethane, hexachlorobenzene, and hexachlorobutadiene by Rangia cuneata occurred at the second affected site. Uptake by Rangia cuneata of hexachlorobutadiene and hexachlorobenzene also occurred at the recovery site, although in smaller amounts, indicating movement of these compounds much farther downstream than indicated by chemical analysis of water and bottom material. The above results indicate that Rangia cuneata has great potential for use as a monitoring tool in areas where contamination by manmade organic compounds may have occurred. This is especially true in areas where the contamination occurs at concentrations below analytical detection limits in water and bottom material. (See also W90-05059) (Author's abstract)
W90-05094

ESTIMATION OF VOLATILIZATION-RATE COEFFICIENTS FOR VOLATILE ORGANIC COMPOUNDS IN BAYOU D'INDE, LOUISIANA.

Geological Survey, Baton Rouge, LA.

D. K. Demas, C. R. Demas, and P. B.

Curwick.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 321-327, 2 fig, 2 tab, 7 ref.

Descriptors: *Fate of pollutants, *Organic pollutants, *Louisiana, *Path of pollutants, *Volatility, *Wastewater outfall, *Industrial wastewater, Desorption, Rate coefficients, Toxic substances, Outfall, Tidal rivers.

Synthetic volatile organic compounds were sampled in water from an industrial outfall and downstream from the outfall in Bayou d'Inde, a small tributary to the lower Calcasieu River, Louisiana, on September 17-18, 1987, to determine volatilization-rate coefficients in a field setting. The method used to calculate the rate coefficients was adapted from a method developed for determining desorption coefficients for reaeration studies. The rate coefficients computed for eight selected volatile organic compounds suggest that production of some volatile organic compounds may be occurring in water from the industrial outfall. In contrast, significant volatilization of these same organic compounds occurred downstream in Bayou d'Inde. Water from the industrial outfall did not mix vertically as it flowed into Bayou d'Inde, indicating the need for accurate time-of-travel information at all depths in tidally affected streams. The study adds to the understanding of processes controlling the fate of toxic substances in the lower Calcasieu River. (See also W90-05059) (Author's abstract)
W90-05095

ABIOTIC PHOTOLYSIS IN THE CALCASIEU RIVER, LOUISIANA.

Geological Survey, Reston, VA.

M. C. Goldberg, K. M. Cunningham, and A. C.

Sigleo.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water-Resources Investigations Report 88-4220, 1989. p 329-340, 6 fig, 2 tab, 12 ref.

Descriptors: *Fate of pollutants, *Calcasieu River, *Photolysis, *Louisiana, *Organic pollutants, *In-

dustrial wastewater, Hydroxide, Abiotic photolysis, Dechlorination, Styrene, Naphthalene, Benzene, Wastewater outfall.

Direct and indirect abiotic photolysis processes can occur in the Calcasieu River, Louisiana. The river was sampled at Bayou d'Inde, which is located at the outfall of an industrial plant. From the sampling point, the channel flows to the Calcasieu Ship Channel located opposite the entrance to Prien Lake. Indirect photolysis was determined by measuring the steady-state hydroxyl radical (OH) concentration in water from the sampling point. The hydroxyl radical concentration (OH) was found to be 3×10^{-15} to 10^{-15} mole/L, which is one order of magnitude greater than is present in most aquatic waters. The magnitude of the OH concentration indicates that a comparatively large amount of indirect photolysis occurs at the sampling point. This is attributed to the presence of a large number of organic molecules that can act as sensitizers. On the basis of the measure (OH)ss concentration, the calculated half-lives of selected organic functional groups subject to oxidation by OH in the Calcasieu River ranges from 2 to 30 hours. Direct photolysis also is expected to occur in the river. Laboratory studies measured the photolytic dechlorination of octachlorostyrene, octachloronaphthalene, and hexachlorobenzene, all of which are present in the Calcasieu River. The quantum yield of octachlorostyrene was 8.6×10^{-2} to the 5th power, of octachloronaphthalene was 0.022, and of hexachlorobenzene was 0.02. It is estimated that these molecules would photolyze in the river with half-lives of 4 to 8 hours. (See also W90-05059) (Author's abstract)
W90-05096

SITE DESCRIPTION AND SUMMARY OF RESEARCH ACTIVITIES ON THE MOVEMENT AND FATE OF CHLORINATED SOLVENTS IN GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.

T. E. Imbrigiotta, and M. Martin.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1989. 988. USGS Water Resources Investigations Report 88-4220, 1989. p 343-350, 3 fig, 5 ref.

Descriptors: *New Jersey, *Groundwater pollution, *Picatinny Arsenal, *Fate of pollutants, *Munitions wastes, *Geohydrology, *Organic solvents, *Path of pollutants, Cores, Microbial degradation, Mathematical models, Moisture.

The U.S. Geological Survey is conducting an interdisciplinary research study of groundwater contamination by chlorinated solvents and other contaminants at Picatinny Arsenal, New Jersey. The hydrogeology, extent of groundwater contamination, and the research activities that are ongoing at the Building 24 site at Picatinny Arsenal are summarized. The groundwater contamination is primarily within the 50-foot thickness of unconfined glacial sediments and extends from Building 24 to Green Pond Brook, the groundwater discharge point. Laboratory and field studies were used to study the effect of soil moisture on trichloroethylene-vapor sorption to the unsaturated zone soil. A mathematical transport model is being developed to test hypotheses on air-phase transport and in situ microbial degradation of chlorinated solvents in the unsaturated zone. Trace-metal distributions and areas of enrichment were determined in core samples at various locations in the plume. Elevated dissolved organic carbon concentrations near Building 24 were explored using a new isolation technique and analysis with carbon-13 nuclear-magnetic-resonance spectroscopy. Microbial populations in soil from the unsaturated zone were determined to range from 0.5 to 6 million organisms/g of soil. Soil microcosms are being used to determine trichloroethylene biotransformation rates for aerobic unsaturated and aerobic saturated conditions and for anaerobic saturated conditions in the presence of a supplementary carbon source. Preliminary areal and cross-sectional solute-transport models were constructed to define the horizontal movement of selected con-

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taminants in the unconfined sediments and the vertical movement of these contaminants within and between aquifers at the site. (See also W90-05059) (Author's abstract)
W90-05097

PRELIMINARY RESULTS OF A STUDY OF THE CHEMISTRY OF GROUNDWATER AT THE BUILDING 24 RESEARCH SITE, PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
T. E. Imbrigiotta, M. Martin, B. P. Sargent, and L. M. Voronin.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p351-359, 5 fig, 1 tab, 6 ref.

Descriptors: *New Jersey, *Groundwater pollution, *Geochemistry, *Water chemistry, *Water pollution sources, *Path of pollutants, *Groundwater chemistry, *Picatinny Arsenal, Trace metals, Organic carbon, Cyanide, Silica, Magnesium.

The water in bedrock and confined aquifers underlying the Building 24 site at Picatinny Arsenal, New Jersey, is similar in chemical composition. The water chemistry of the unconfined aquifer differs greatly, depending on whether the wells sampled are within or outside of the contaminant plume. Uncontaminated water from a well in the unconfined aquifer is a sodium chloride bicarbonate type. Water from a well immediately downgradient from the Building 24 source area is a sodium chloride type. The areal and vertical distributions of trichloroethylene and sulfate in the unconfined aquifer are similar, indicating that organic and inorganic compounds are derived from sources in the Building 24 area, and that both tend to be transported along the same flow paths to Green Pond Brook. Other observations are that: (1) high dissolved organic carbon and trace-metal concentrations are present only within 500 ft of the Building 24 source area; (2) high dissolved organic carbon concentrations near the source are not caused by priority pollutants; (3) cyanide is present above detection limits as far as 900 ft downgradient from the source; (4) silica concentrations (6 to 8 mg/L) are about one-half the background concentrations where high dissolved organic carbon concentrations are present near the source; and (5) elevated magnesium concentrations are present downgradient from the source near the discharge point of the groundwater system. (See also W90-05059) (Author's abstract)
W90-05098

DISTRIBUTION OF TRICHLOROETHYLENE IN SOIL GAS ABOVE CONTAMINATED GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
J. A. Smith, J. A. Kammer, C. T. Chiou, and D. E. Kile.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p361-370, 5 fig, 1 tab, 9 ref.

Descriptors: *Groundwater pollution, *Soil gases, *New Jersey, *Path of pollutants, *Vadose zone, *Trichloroethylene, *Picatinny Arsenal, Soil contamination, Vapors.

The distribution of trichloroethylene vapor in soil gas has been studied above a contaminant plume at Picatinny Arsenal in Morris County, New Jersey. Laboratory studies indicate that trichloroethylene vapor sorption to soil is suppressed by moisture but only up to saturation soil moisture content (the moisture content corresponding to 100% relative humidity). Above saturation moisture content, trichloroethylene vapor sorption can be approximated by a conventional soil-water isotherm. A statistical comparison of field moisture content to saturation moisture content for six soil samples collected from the vadose zone at Picatinny Arsenal indicate that the field moisture content of the vadose-zone soil is above saturation moisture con-

tent at a 0.05 probability significance level. Gas samples from the vadose zone were collected from two or three depths at each of six locations above the main axis of the groundwater solute plume. In general, trichloroethylene-vapor concentrations decreased with horizontal distance downgradient from the contaminant source and vertical distance above the water table. The concentration of trichloroethylene in all vapor samples collected from depths within 0.75 m of land surface was less than the analytical quantitation limit of 40 nanograms/L. The highest trichloroethylene concentration (7,300 nanograms/L) was measured in gas samples collected approximately 0.3 m above the water table near the source of contamination. (See also W90-05059) (Author's abstract)
W90-05099

MICROBIOLOGICAL TRANSFORMATION OF TRICHLOROETHYLENE IN SOIL AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
T. Ehlik.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p 371-376, 3 fig, 2 tab.

Descriptors: *New Jersey, *Trichloroethylene, *Picatinny Arsenal, *Groundwater pollution, *Fate of pollutants, *Biodegradation, Metal-plating wastes, Vinyl chloride, Biotransformation, Soil water.

Shallow groundwater at Picatinny Arsenal in north-central New Jersey has been contaminated with trichloroethylene as a result of metal-plating and degreasing operations in Building 24. The presence of dichloroethylene and vinyl chloride in groundwater near Building 24 indicates that biotransformation of trichloroethylene may be occurring under anaerobic conditions at the site. Preliminary results of soil microcosm studies indicate that biotransformation of trichloroethylene in the unsaturated zone under aerobic conditions is negligible. The biotransformation of trichloroethylene in the upper part of the saturated zone in the presence of methane is being investigated. (See also W90-05059) (Author's abstract)
W90-05100

PRELIMINARY RESULTS OF A STUDY TO SIMULATE TRICHLOROETHYLENE MOVEMENT IN GROUND WATER AT PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, West Trenton, NJ.
M. Martin.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p377-383, 3 fig, 2 ref.

Descriptors: *Picatinny Arsenal, *Path of pollutants, *Groundwater movement, *Path of pollutants, *Groundwater pollution, *New Jersey, *Trichloroethylene, Flow models, Distribution, Model studies, Volatilization.

Research activities at the Building 24 contaminant site at Picatinny Arsenal, New Jersey, include the development of a multilayer groundwater flow model, and an areal and a cross-sectional, two-dimensional, solute-transport model as a means to define the distribution and movement of chlorinated solvents in groundwater. Although the models are not calibrated, the results of the preliminary simulations have been useful in improving the conceptual model and the modeling approach. Generally, the simulated head distribution is most sensitive to the areal and temporal distribution of groundwater recharge and is less sensitive to the definition of the hydrologic framework and hydraulic characteristics. In contrast, simulated groundwater velocities and flow rates are very sensitive to hydraulic characteristics. The total trichloroethylene mass within the simulated contaminant plume is about 3,000 kg, or the equivalent of about 2,000 liters of pure trichloroethylene. About 70% of the solute mass is in areas with

simulated concentrations between 1 and 10 mg/L. About 15% of the solute mass is simulated in the near-source area, where trichloroethylene concentrations are greater than 10 mg/L. Simulated rates of trichloroethylene loss from the unconfined groundwater flow system indicate that loss from volatilization may be on the order of hundreds of grams/day and may be one or two orders of magnitude more than the loss from the discharge of groundwater to confined aquifers or to surface-water bodies. (See also W90-05059) (Author's abstract)
W90-05101

DISTRIBUTION OF MAJOR AND TRACE ELEMENTS IN CORE SAMPLES FROM PICATINNY ARSENAL, NEW JERSEY.

Geological Survey, Denver, CO.
S. A. Wilson, and J. E. Taggart.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p385-388, 1 fig, 2 tab, 4 ref.

Descriptors: *Path of pollutants, *Pollutant identification, *New Jersey, *Heavy metals, *Waste disposal, *Picatinny Arsenal, Spectroscopy, X-ray fluorescence, Cores, Chromium, Copper, Lead, Nickel, Zinc, Vanadium, Water depth.

Core samples collected at various distances from a waste-disposal pit were analyzed for trace and major element concentrations using Inductively Coupled Argon Plasma Atomic Emission Spectroscopy and Wavelength Dispersive X-ray Fluorescence. It was determined that concentrations of chromium, copper, lead, nickel, and zinc were two to three times higher than background levels, and vanadium concentrations were one and a half to two times higher than background levels at sites downgradient from the disposal pit. Vertical variations in trace-metal concentrations also exist. Metal concentrations increased between 11 and 14 ft, then decreased to background concentrations below 14 ft at the sample site closest to the disposal pit. A similar variation in metal concentration was observed in cores from a site farther downgradient from the disposal pit, except that the maximum concentration occurred at the 29-ft depth. (See also W90-05059) (Author's abstract)
W90-05102

BIOTRANSFORMATION OF CHLORINATED HYDROCARBONS AND ALKYL BENZENES IN AQUIFER MATERIAL FROM THE PICATINNY ARSENAL, NEW JERSEY.

Oklahoma Univ., Norman. Environmental and Ground Water Inst.
B. H. Wilson.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p389-394, 1 fig, 2 tab, 12 ref.

Descriptors: *New Jersey, *Groundwater pollution, *Chlorinated hydrocarbons, *Path of pollutants, *Fate of pollutants, *Picatinny Arsenal, *Alkylbenzenes, Biotransformation, Degreasers, Petroleum products.

The most common groundwater contaminants at Picatinny Arsenal, New Jersey, are chlorinated solvents used as degreasers and the soluble constituents of petroleum products. Of these, trichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, benzene, toluene, and the xylenes are most commonly found. Trichloroethylene and 1,1,1-trichloroethane are not biologically degraded in oxygenated groundwater and persist in those environments. In anoxic subsurface materials, they may undergo a reductive dechlorination (chlorine is replaced with a hydrogen) to form new compounds that are more mobile than the parent compounds and, in the case of vinyl chloride, are more carcinogenic. The groundwater from Picatinny Arsenal in north-central New Jersey has been contaminated by two partially overlapping plumes from discharged wastewater from a metal-plating

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wastewater treatment system and from spilled diesel fuel. Trichloroethylene is the predominant contaminant from the wastewater-treatment system with tetrachloroethylene, 1,1,1-trichloroethane, cis-1,2-dichloroethylene, and vinyl chloride also present. To confirm field evidence of biological transformation of the chlorinated solvents, the fate of trichloroethylene and 1,1,1-trichloroethane was monitored in aquifer material from the part of the plume exposed to trichloroethylene only and from the part of the plume exposed to both trichloroethylene and the diesel fuel. Their fate was observed both with and without the presence of benzene, toluene, chlorobenzene, and o-xylene to determine their effect on reductive dechlorination. Initial results indicate the removal of a maximum of 65% trichloroethylene in material exposed to both trichloroethylene and the diesel fuel in microcosms not containing the alkylbenzenes. Substantial removals of the remaining compounds were also observed, with 2% of the original concentration of toluene remaining at the end of 4 weeks of incubation. (See also W90-05059) (Author's abstract) W90-05103

REGIONAL APPRAISAL OF GROUNDWATER QUALITY IN FIVE DIFFERENT LAND-USE AREAS, LONG ISLAND, NEW YORK.

Geological Survey, Syosset, NY.
D. A. V. Eckhardt, S. F. Siwiec, and S. J. Cauller.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p397-404, 4 fig.

Descriptors: *Water pollution sources, *Groundwater chemistry, *New York, *Groundwater pollution, Land use, Sewers, Volatile organic compounds, Insecticides, Model studies.

Water-quality data from 90 shallow wells screened in the upper glacial (water-table) aquifer beneath five different land-use areas in Nassau and Suffolk Counties, Long Island, were compared to assess the effects of human activities and land-use practices on groundwater quality. The areas, which range from 22 to 44 sq mi, represent suburban land sewered more than 22 years (long-term sewered), suburban land sewered less than 8 years (recently sewered), unsewered suburban land, agricultural land, and undeveloped (forested) land. All five areas overlie the regional water-table divide, where downward-moving water recharges the deeper aquifer system. The most frequently detected volatile organic compounds were 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene; these were found primarily in samples from the recently sewered and unsewered suburban areas. None were detected in samples from the long-term sewered suburban area. Carbamate insecticide residues, mainly aldicarb metabolites and carbofuran, were found almost exclusively in samples from the agricultural area. Organochlorine insecticide residues, mainly dieldrin and chlordane, were detected at low concentrations in all five areas. Maximum-likelihood logistic regression analysis of three predictor variables—population density, percentage of industrial and commercial land, and percentage of residential land within a 1/2 mile radius of the 90 wells—was used to predict the probability of volatile organic compound detection in shallow groundwater. Recent water quality data from more than 300 wells across the two-county area were used to verify model results. (See also W90-05059) (Author's abstract) W90-05104

OVERVIEW OF THE RELATIONS OF NON-POINT-SOURCE AGRICULTURAL CHEMICAL CONTAMINATION TO LOCAL HYDROGEOLOGIC, SOIL, LAND-USE, AND HYDRO-CHEMICAL CHARACTERISTICS OF THE HIGH PLAINS AQUIFER OF NEBRASKA.

Geological Survey, Lincoln, NE.
D. Druliner.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988.

USGS Water-Resources Investigations Report 88-4220, 1989. p411-435, 16 fig, 3 tab, 8 ref.

Descriptors: *Groundwater pollution, *Groundwater chemistry, *Nebraska, *Water pollution sources, *Nonpoint pollution sources, *Nitrates, *Atrazine, Geochemistry, Land use, Statistical analysis, Agricultural chemicals, Hydraulic conductivity, Water depth, Wells.

Concentrations of nitrate higher than the U.S. Environmental Protection Agency's 10 mg/L standard for drinking water and detectable concentrations of atrazine herbicide have been found in groundwater in many areas of the High Plains aquifer of Nebraska. The concentrations of these contaminants depend on local hydrogeologic, soil, and land use, and prevailing hydrochemical characteristics. Scatter plots and statistical analysis of many of these explanatory variables as functions of nitrate and atrazine concentrations in groundwater have revealed relations that may be useful in predicting areas susceptible to groundwater contamination by agricultural chemicals. Multiple linear-regression techniques were used to determine the relative significance of 22 and 24 explanatory variables to concentrations of nitrate and atrazine in groundwater, respectively. Specific conductance, average hydraulic conductivity of the unsaturated zone, and the clay content of the soil, together accounted for the largest variations in the nitrate concentrations in groundwater. Average hydraulic conductivity of the unsaturated zone, specific conductance, irrigation-well density, herbicide-application data, average screened well depth, and depth to water, together accounted for the largest variations in atrazine concentration in groundwater. (See also W90-05059) (Author's abstract) W90-05106

RELATIONS BETWEEN LAND USE AND WATER QUALITY IN THE HIGH PLAINS AQUIFER OF SOUTH-CENTRAL KANSAS.

Geological Survey, Lawrence, KS.
J. O. Helgesen, and A. T. Rutledge.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p437-443, 3 fig, 5 ref.

Descriptors: *Nonpoint pollution sources, *Land use, *Groundwater pollution, *Kansas, *Rangeland, *Agricultural chemicals, Atrazine, Clays, Vadose zone, Irrigation, Solute transport.

Results of sampling from the High Plains aquifer in south-central Kansas indicate differences in groundwater quality between rangeland areas and irrigated cropland areas of several square miles. Concentrations of several dissolved inorganic constituents are higher beneath cropland areas than beneath rangeland as a result of the application of irrigation water and agricultural chemicals. The rarity of atrazine herbicide in samples of groundwater may reflect degradation and (or) retardation of atrazine in the vadose zone. Clay layers in the vadose zone probably restrict downward movement of water and chemicals in most of the study area. Within irrigated cropland areas, water quality as characterized by samples from irrigation wells is not significantly different than water quality as characterized by samples from small-yield wells away from irrigated fields, reflecting lateral solute transport within the discrete areas. (Author's abstract) W90-05107

PLANNED STUDIES OF HERBICIDES IN GROUND AND SURFACE WATER IN THE MID CONTINENTAL UNITED STATES.

Geological Survey, Iowa City, IA.
M. R. Burkart, S. E. Ragone, E. M. Thurman, and C. A. Perry.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p445-452, 3 fig, 16 ref.

Descriptors: *Groundwater pollution, *Statistical analysis, *Water pollution sources, *Herbicides,

*Fate of pollutants, *Path of pollutants, *Atrazine, Soil chemistry, Decomposition, Water quality management.

A plan was developed to study the effect of natural and human factors on the occurrence of herbicides, such as atrazine, in ground and surface waters in the Midwest. The key question to be answered is: 'What happens to an herbicide after its application.' Procedures are provided that integrate information from a wide variety of deterministic and statistical studies of atrazine. These studies range in scale from laboratory and field plots, to regional-scale investigations. Processes, such as chemical decomposition, are physical, chemical, and biological actions that can influence the transformation, transportation, and storage of atrazine. Factors, such as soil pH, are variables that can affect which process plays a dominant role. A research matrix is developed that uses a mass-balance concept to account for the distribution of atrazine in the environment and to identify areas of needed research. A geographic information system that will permit interpretation of regional information and evaluation of spatial variability of important natural and human factors, such as atrazine application rates and depth to water was developed. The plan includes use of statistical methods to relate regional patterns of the occurrence of atrazine to a limited number of factors. Full implementation of the plan may take 5 to 10 years or more depending on the availability of information and the need for additional studies. The plan involves an iterative process that uses information from laboratory and field plot research of natural processes to direct the statistical analysis of the regional distribution of factors. The results of the statistical analysis will be used to identify areas where factors can be measured in more detail and verified. This planned research will be the scientific basis for water resources managers to develop guidelines for protecting water quality. (See also W90-05059) (Author's abstract) W90-05108

PRELIMINARY ASSESSMENT OF THE FATE AND TRANSPORT OF SYNTHETIC ORGANIC AGROCHEMICALS IN THE LOWER MISSISSIPPI RIVER AND ITS TRIBUTARIES.

Geological Survey, Denver, CO.
W. E. Pereira, C. E. Rostad, and T. J. Leiker.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p453-464, 5 fig, 3 tab, 6 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Water pollution sources, *Mississippi River, *Agricultural chemicals, *Nonpoint pollution sources, *Herbicides, Triazines, Acylamide, Degradation products, DDT, Catfish, Bioaccumulation.

The Mississippi River discharges an average of 18,400 cu m/sec of water into the Gulf of Mexico. This large river basin includes extensive agricultural areas. Millions of pounds of agrochemicals are applied annually in these areas. Therefore, point-source pollution of the river by industrial chemicals may be a relatively minor environmental problem compared with nonpoint-source pollution by synthetic organic agrochemicals transported from these agricultural watersheds. Studies being conducted by the U. S. Geological Survey at 16 different stations along the lower Mississippi River and its tributaries, representing a 1,200 mile reach, have confirmed that these compounds are distributed in water, sediments, and lipid tissue of catfish. Several triazine and acylamide herbicides and their degradation products were identified in water and suspended sediments. These compounds include atrazine and its degradation products. Preliminary studies have shown that small quantities of these compounds also are associated with silt and clay fractions. Loads of several herbicides and their degradation products in the lower Mississippi River and its tributaries are reported. Loads for 2,6-diethylaniline indicate that this compound probably is generated from a point source near St. Louis. More hydrophobic agrochemicals, such as

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DDT and its degradation products DDE and DDD, and dieldrin, chlordane, hexachlorobenzene, and dachal are bioconcentrated in the lipid tissue of catfish. Presence of these compounds in stream biota demonstrates the importance of these organisms as sensors and concentrators of hydrophobic organic pollutants. Processes such as sorption, biodegradation, and bioconcentration affect the distributions of synthetic organic agrochemicals in the Mississippi River. (See also W90-05059) (Author's abstract) W90-05109

ASSESSMENT OF POTENTIAL FOR CONTAMINATION OF THE UPPER FLORIDAN AQUIFER FROM DRAINAGE-WELL RECHARGE IN THE ORLANDO AREA, CENTRAL FLORIDA.

Geological Survey, Orlando, FL.

E. R. German.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p465-472, 3 fig, 3 tab, 6 ref.

Descriptors: *Water pollution sources, *Urban areas, *Groundwater pollution, *Florida, *Drainage wells, *Storm runoff, Aquifers, Chemical analysis, Nutrients, Trace elements, Comparison studies, Hydrology, Geochemistry.

The Orlando area, Florida, was selected for study of the potential for contamination of groundwater from drainage-well inflow. About 400 drainage wells are used for stormwater-runoff disposal and regulation of lake stage. The Upper Floridan aquifer in the Orlando study area can be viewed conceptually as a continuously stirred tank reactor for conservative constituents, recharged by drainage from disposal of stormwater runoff. According to this concept, a conservative constituent injected at constant concentration would presently (1988) be at about 70% of the equilibrium concentration in the aquifer of the study area. This conservative constituent equilibrium concentration is estimated to be about 30% of the average concentration in the drainage-well inflow. A comparison of water quality between an undeveloped control area and the Orlando urban area indicated significantly greater concentrations of most major constituents and nutrients in the urban area. The greater concentrations of ammonia and total organic carbon in the urban area compared to the control area probably are attributable to the drainage-well inflow. The greater concentrations of the major constituents in the urban area compared to the control area probably are the result of differences in geochemical and hydrologic factors. Frequency of detection of trace elements and volatile organic compounds was not statistically greater in the urban area than in the control area at a probability significance levels of 0.05. (See also W90-05059) (Author's abstract) W90-05110

STATISTICAL COMPARISON OF GROUNDWATER QUALITY IN FOUR LAND-USE AREAS OF STRATIFIED-DRIFT AQUIFERS IN CONNECTICUT.

Geological Survey, Hartford, CT.

S. J. Grady.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p473-481, 1 fig, 2 tab, 19 ref.

Descriptors: *Groundwater pollution, *Land use, *Water pollution sources, *Nonpoint pollution source, *Connecticut, Statistical analysis, Agricultural chemicals, Conductivity, Temperature, Chemical analysis, Urban areas.

Chemical data for water samples collected from 83 wells in undeveloped, agricultural, residential, and mixed industrial and commercial areas that overlie four stratified-drift aquifers in Connecticut were statistically compared to determine if land use affects groundwater quality. Analysis of variance on the ranks of constituent concentrations and contin-

gency-table analysis of the frequency of detections of highly censored constituents indicate that 26 water quality variables differ at the 0.05-significance level for one or more of the land uses. For most constituents, concentrations or detections are smallest in the undeveloped areas. In agricultural areas fertilizer and pesticide use significantly increase the specific conductance and the concentration or detection frequency of calcium, magnesium, hardness, sulfate, nitrate plus nitrite, ammonia, dissolved solids, strontium, boron, lithium, methylene-blue active substance, 1,2-dichloropropane, and atrazine. A variety of nonpoint sources in residential and (or) industrial and commercial areas contribute to significantly elevated water temperature plus higher concentrations or detection frequencies of all of the aforementioned constituents (except 1,2-dichloropropane and atrazine), as well as sodium, chloride, beryllium, chromium, iron, manganese, trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, chloroform, and acid-neutral and base-neutral extractable organic compounds compared to groundwater samples from undeveloped and (or) agricultural land-use areas. (See also W90-05059) (Author's abstract) W90-05111

USE OF A SIMPLIFIED TRANSPORT MODEL FOR PESTICIDES IN THE UNSATURATED ZONE.

Geological Survey, Richmond, VA.

A. T. Rutledge, and J. O. Helgesen.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p523-530, 3 fig, 1 tab, 11 ref.

Descriptors: *Soil contamination, *Soil water, *Path of pollutants, *Unsaturated flow, *Groundwater pollution, *Pesticides, Model studies, Percolation, Organic carbon, Water depth, Lithologic layers.

A steady-state mathematical model calculates pesticide residence time and fraction of pesticide remaining as functions of depth in the unsaturated zone. The use of the model in an example problem is demonstrated, and results of the use of the model on a simplified hypothetical situation are used to determine sensitivity of groundwater contamination potential to selected variables. The model can simulate the presence of numerous lithologic layers in the unsaturated zone, continuous water-content variation with depth, pesticide retardation, pesticide-decay rates that differ between layers, and root uptake of pesticide. The model output includes time and fraction of pesticide remaining as functions of depth, if the pesticide is introduced at the land surface. If the fraction of pesticide remaining at the water table represents contamination potential, then the model indicates the variables to which the groundwater contamination potential is most sensitive. For conditions that represent the subhumid to semiarid region of the Midwestern United States, these variables are, in order of importance, deep percolation rate, organic carbon content in the bottom part of the unsaturated zone, half-life of pesticides, and depth to the water table. (See also W90-05059) (Author's abstract) W90-05116

BIODEGRADATION PATHWAYS FOR BENZOTHIOPHENE IN METHANOGENIC MICROCOSMS.

Geological Survey, Menlo Park, CA.

E. M. Godsy, and D. Grbic-Galic.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p559-564, 2 fig, 16 ref.

Descriptors: *Biodegradation, *Microbial degradation, *Methane bacteria, *Fate of pollutants, *Creosote, Florida, Benzothiophene, Chromatography, Spectrometry, Methanogenesis, Hydrogen sulfide, Carbon dioxide.

Microbial transformation of benzothiophene, the major two-ring sulfur heterocyclic compound in

creosote, has been studied under methanogenic conditions. Microcosms seeded with low-biomass methanogenic aquifer material from an abandoned wood-preserving site in Pensacola, in northeastern Florida, were fed benzothiophene at a concentration of 10 mg/L as the sole carbon and energy source in an anaerobic mineral medium. High-performance liquid chromatography and gas chromatography/mass spectrometry were used to separate and identify intermediate compounds that appeared before the onset of methanogenesis. The first transformation step consisted of oxidation and cleavage of the S-heterocyclic ring. After cleavage of this ring the substituent side chains and the remaining homocyclic ring were subjected to various reactions including oxidation, decarboxylation, desulfurylation, and O-methylation. These reactions were followed by reduction of the homocyclic ring, cleavage of this ring, B-oxidation, and mineralization to methane, carbon dioxide, and hydrogen sulfide. The major degradation pathway intersects segments of both the benzoic acid and phenol anaerobic-degradation pathways. A minor pathway starting with the oxidation of the homocyclic ring with subsequent ring reduction, ring cleavage, degradation of the remaining S-heterocyclic ring, and mineralization was also observed. (See also W90-05059) (Author's abstract) W90-05120

MOVEMENT OF INORGANIC CONTAMINANTS IN ACIDIC WATER NEAR GLOBE, ARIZONA.

Geological Survey, Tucson, AZ.

J. H. Eychaner.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p567-575, 5 fig, 1 tab, 11 ref.

Descriptors: *Acid mine drainage, *Path of pollutants, *Mine drainage, *Acidic water, *Heavy metals, *Arizona, Aluminum, Copper, Iron, Hydrogen ion concentration, Sulfates, Globe, Manganese.

Acidic water has contaminated a groundwater flow path 15 kilometers long to a depth of at least 50 m in a copper-mining district in Arizona. Aluminum, copper, and iron concentrations exceed 100 mg/L at pH less than 5. The aquifer includes a surficial unconsolidated alluvium as much as 50 m thick overlying a thicker, carbonate-cemented alluvial conglomerate. Movement of acidic water is retarded by reaction with calcite, but low-pH water may reach a perennial stream within 6 to 15 years. The stream is already contaminated with about 2,000 mg/L of sulfate and 30 mg/L of manganese at a pH greater than 6. (See also W90-05059) (Author's abstract) W90-05121

SIMULATION OF GROUND- AND SURFACE-WATER FLOW IN THE GLOBE AREA, ARIZONA.

Geological Survey, Tucson, AZ.

C. C. Neville.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p577-579, 1 fig, 2 ref.

Descriptors: *Acid mine drainage, *Path of pollutants, *Model studies, *Mine drainage, *Acidic water, *Arizona, *Heavy metals, Aquifers, Groundwater pollution, Surface-groundwater relations, Simulation analysis, Stream pollution, Globe.

Acidic water with elevated concentrations of metals has contaminated a stream and alluvial aquifer in a mining district near Globe, Arizona. The aquifer consists of a narrow layer of unconsolidated alluvium along the drainage system that overlies an extensive conglomerate. The flow system is being simulated by a three-dimensional, finite-difference, groundwater flow model (MODFLOW) that maintains a streamflow water budget. Stream-aquifer interactions will be simulated with a

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streamflow-routing package, and results of the simulations are to be used to evaluate rates of movements of the contaminants in subsequent modeling. (See also W90-05059) (Author's abstract)
W90-05122

MANGANESE IN CHANNEL SEDIMENTS OF PINAL CREEK, ARIZONA.
Arizona State Univ., Tempe. Dept. of Geography. J. K. Haschenburger.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p593-597, 2 fig, 1 tab, 6 ref.

Descriptors: *Acid mine drainage, *Path of pollutants, *Water pollution sources, *Mine drainage, *Manganese, *Arizona, *Globe, *Manganese oxide, *Precipitates, *Sediment transport, *Groundwater movement, *Stream pollution.

Elevated concentrations of dissolved manganese in the lower perennial reach of Pinal Creek are linked to groundwater transport from the Globe-Miami mining district, Arizona. This study investigates the manganese that has precipitated onto stream sediments as oxides. Representative channel measurements and sediment samples were collected within 200-meter-long sampling segments in five geomorphically distinct subreaches. Samples were collected from the perennial-flow channel and from that part of the flood plain that is sufficiently inundated for manganese-oxide deposition. Sampling was designed in anticipation of finding higher manganese concentration in areas of fine-grained sediments than in areas of coarser sediments. Manganese mass in sediments within 60 mm of the surface of the 12.9-km length of channel that contains perennial flow is estimated to be a minimum of 37 megagrams. This estimate is the sum by subreaches of volumetric channel dimensions, sediment bulk density, and sample manganese concentration in excess of background concentration. A zone of increased manganese concentration in channel margins immediately adjacent to the flowing stream is estimated to contain an additional 10 megagrams. The mass of manganese in stream sediments has been increased by 135% because of upstream mining activity. Some manganese oxides have been removed from temporary storage by sediment-transport processes. (See also W90-05059) (Author's abstract)
W90-05124

RESEARCH ACTIVITIES RELATED TO ACIDIC WATER NEAR GLOBE, ARIZONA.

Geological Survey, Tucson, AZ.
J. H. Eychaner.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p599-601, 3 ref.

Descriptors: *Mine drainage, *Acidic water, *Copper, *Heavy metals, *Acid mine drainage, *Arizona, *Path of pollutants, *Sampling, *Globe, *Hydrogen ion concentration, *Microbial degradation, *Precipitates, *Groundwater pollution, *Stream pollution.

In an area contaminated by acidic water related to copper mining, many geochemical reactions involving metals may be studied in ground and surface water. Drilling is planned near Globe, Arizona, to determine whether predicted secondary minerals form in a complex field environment as pH rises from less than 5 to more than 6 and metal concentrations decrease from mg/L to micrograms/L. Solid-solution minerals or co-precipitates may be formed, and bacteria may mediate the process. Recent elimination of a major contaminant source may establish a second transition zone and allow further evaluation of geochemical models. Sampling methods for metallic colloids in groundwater are to be tested, and reconnaissance sampling is planned for tritium, organic compounds, and alpha radiation. Within a 12-km reach of a perennial stream, changes in concentration of several elements by as much as 50% could be studied

without mixing with uncontaminated streamflow. Breakthrough of several metals to the stream is expected within about 6 years. (See also W90-05059) (Author's abstract)
W90-05125

ASSESSMENT OF POTENTIAL TOXIC PROBLEMS IN NON-URBAN AREAS OF PUGET SOUND.
Tetra Tech, Inc., Bellevue, WA.
For primary bibliographic entry see Field 5C.
W90-05129

EFFECTS OF FLY ASH AND FLUE-GAS DESULFURIZATION WASTES ON GROUNDWATER QUALITY IN A RECLAIMED LIGNITE STRIP MINE DISPOSAL SITE.
North Dakota Mining and Mineral Resources Research Inst., Grand Forks.
F. W. Beaver, G. H. Groenewold, O. E. Manz, and D. J. Hassett.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-001048. Price codes: A10 in paper copy, A01 in microfiche. Report No. DOE/FC/10120-2550, Vol. 1, August 1987. 273p, 256 fig, 30 ref. DOE Contract No. AK18-80FC10120.

Descriptors: *Path of pollutants, *Leaching, *Chemical wastes, *Land reclamation, *Strip mines, *Waste disposal, *Landfills, *Water pollution effects, *Fly ash, *Groundwater quality, *Desulfurization, *Arsenic, *Selenium, *Molybdenum, *Lead, *Barium, *Chromium, *Mercury, *Geohydrology, *Sulfates, *Hydrogen ion concentration, *Fate of pollutants.

Coal conversion wastes were generated at a lignite-fired, steam-electric power station near Center, North Dakota, and were buried in unsaturated and saturated settings within the nearby strip mine, typical of settings used by the industry. The field study of the effects of fly ash and flue gas desulfurization (FGD) wastes on groundwater quality in a reclaimed lignite strip mine disposal site ran for eight years beginning in 1978. More than 15,000 water level recordings allowed precise definition of groundwater flow and occurrence at the study site. The base of the spoils commonly constitutes the major aquifer in the disturbed portion of the post-reclamation setting. More than 12,000 chemical analyses for major cations and anions, As, Se, Mo, Ba, Pb, Cr, Hg, and other constituents were performed on groundwater samples from selected settings and strata during this study. The hydrogeochemical data indicate that both the fly ash and the FGD waste initially generate highly mineralized leachates from entrained water. Leachates are characterized by relatively high Na, Mo, Se, As, and SO₄ concentrations. Fly ash generates an initially high pH leachate. FGD wastes produce normal (6-9) pH values. Leachate pH is quickly buffered to the 6-9 range within the sediments. As and Se are simultaneously attenuated to acceptable levels. Iron hydroxide coatings on the sediments resulting from previous alternate wetting and drying cycles may provide a mechanism for alkaline pH buffering with concurrent As and Se adsorption. Lead, Cd, and Ba are maintained at low levels by sulfate and carbonate precipitation reactions. Molybdenum remains mobile in this hydrogeochemical setting. A disposal site, well above the reestablished groundwater table, protected from recharge, is considered the best setting for disposal of these wastes because very little leachate forms. (See also W89-08526) (Author's abstract)
W90-05131

EVALUATION OF THE AQUATIC TOXICITY AND FATE OF BRASS DUST USING THE STANDARD AQUATIC MICROCOSM.
Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD.
For primary bibliographic entry see Field 5C.
W90-05143

CHARACTERIZATION OF SPATIAL AND TEMPORAL TRENDS IN WATER QUALITY IN PUGET SOUND.

Tetra Tech, Inc., Bellevue, WA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134290. Price codes: A18 in paper copy, A01 in microfiche. Report No. EPA 503/3-88-003, July 1988. 425p, 150 fig, 23 tab, 91 ref, 6 append. EPA Contract Nos. 68-03-3319 and 68-02-4341.

Descriptors: *Water pollution sources, *Puget Sound, *Spatial distribution, *Temporal distribution, *Water quality, *Monitoring, *Sulfite liquors, *Coliforms, *Phytoplankton, *Salinity, *Temperature, *Dissolved oxygen.

A study was conducted to assess whether water quality in Puget Sound has changed over time. The major focus was nutrient enrichment and the enhancement of algal blooms. The physical variables investigated were salinity and water temperature. The chemical variables investigated were concentrations of dissolved oxygen, inorganic nitrate, and orthophosphate. Temporal trends in water quality were analyzed at 13 study areas around Puget Sound. Study areas were located in northern Puget Sound (one), central Puget Sound (four), southern Puget Sound (five), and Hood Canal (three). Salinity values decreased and water temperature values increased in most areas. Water temperature values increased in 7 of the 13 study areas and decreased in only 2 of the 13 study areas. Water temperatures appear to be influenced by climate. At the study sites where increases in water temperatures were detected, data collection began during the cool periods of the early 1930s and the early 1950s. Dissolved oxygen (DO) concentrations increased in 7 of the 13 study areas, all of which are located in the southern sound or Hood Canal. The sites in the southern sound were influenced by unusually high DO concentrations in 1986, the last year included in the study. Although the cause of these high DO concentrations could not be determined, they may have occurred during intense algal blooms. Few credible trends in the values of the standard phytoplankton indicators were detected in most of the study areas. Phytoplankton concentrations appear to have increased in the Carr Inlet study area. A statistical decrease in phytoplankton concentrations was detected at the Point Jefferson study area, while a statistical increase in phytoplankton concentrations was detected at the Nisqually Reach study area. However, both of these changes appear to have been caused by erratic fluctuations, rather than by systematic trends. Concentrations of sulfite waste liquor declined in all four study areas near pulp mills. A decline in fecal coliform bacteria concentrations was detected at the Nisqually Ranch study area. (Lantz-PTT)
W90-05162

ABSTRACTS OF PUBLICATIONS AND PRESENTATIONS: 1985-1986.

Environmental Protection Agency, Washington, DC. Office of Acid Deposition, Environmental Monitoring, and Quality Assurance.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-102545. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/9-88/018, September 1988. 71 p.

Descriptors: *Bibliographies, *Acid rain effects, *Acid rain, *Abstracts, *Information exchange, *Publications, *Monitoring, *Fate of pollutants, *Water pollution control.

In 1980, the U.S. Environmental Protection Agency (EPA) implemented the Aquatic Effects Research Program (AERP) as part of the National Acid Precipitation Assessment Program. The AERP, a part of EPA's Office of Research and Development, is administered by the Acid Deposition and Research Division in the Office of Acid Deposition, Environmental Monitoring, and Quality Assurance. Six EPA Laboratories cooperate in AERP research: the Environmental Research Laboratories in Corvallis, Oregon, and Duluth, Minnesota; the Environmental Monitoring Systems Laboratories in Las Vegas, Nevada, Cincinnati, Ohio, and Research Triangle Park, NC; and the Atmospheric Sciences Research Laboratory in Research Triangle Park, NC. The bibliography contains in-

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formation on publications and presentations authored or coauthored by AERP-EPA and contractor personnel in 1985 and 1986. Major activities during this time included field surveys in the National Surface Water Survey and the Direct/Delayed Response Project, pilot studies in the Episodic Response Project, and initiation of the Watershed Processes and Manipulation Project at Little Rock Lake, WI. Planning and design efforts were also underway for other component projects, including the Watershed Manipulation Project, Regional Case Studies, and a long-term monitoring effort. (Author's abstract)
W90-05165

PROCEEDINGS OF THE ENGINEERING FOUNDATION CONFERENCE: GROUND-WATER CONTAMINATION.

For primary bibliographic entry see Field 5G.
W90-05169

NATIONAL ASSESSMENT OF THE STATE OF GROUNDWATER CONTAMINATION—AN OVERVIEW.

California Univ., Davis. Dept. of Agricultural Economics.

J. H. Snyder.

IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 7-12.

Descriptors: *Hydrologic data collections, *Groundwater pollution, *Groundwater quality, *Water quality control, *Water pollution sources, Public health, Databases, Economic aspects, Water pollution control, Trichloroethylene, Industrial wastes, Water quality standards.

A number of studies at the national, regional, and state levels have focused on cataloging the state of current knowledge on groundwater contamination. In all instances, these studies indicate that, at present, we have only scratched the surface in identifying the full extent of the contamination problem. The main reason for this observation is that most of the studies have been in response to a specific identified crisis or that the level of precision for the larger area studies has been minimal. It appears that the majority of available information focusing on groundwater contamination is scattered, poorly organized, and lacks comparability and it is thus considered to be anecdotal. However, from what information there is, some worthwhile generalizations are possible. Trichloroethylene (TCE) was uniformly reported as the single most widely dispersed synthetic organic chemical contaminant. The ranking of the sources of groundwater contamination were reported to be: (1) industrial and manufacturing activity, (2) underground storage tanks, (3) underground pipelines, (4) surface impoundments, (5) landfills and dumps, (6) septic systems, (7) drainage and injection wells, (8) agriculture, (9) households, (10) 'midnight' (illegal) dumping, and (11) transportation spills. A very important first move for expanding the groundwater contamination database is to develop consistency and uniformity in the approach, measurement, and maintenance of database information on groundwater contamination. The major impediment to the development of an optimal groundwater contamination database is cost. Perhaps the greatest challenge to expanding the informational database lies in projecting future contamination and contaminants. Many specific substances disposed of during the 1950s and 1960s were not identified as potentially damaging substances until the 1980s. The identified lack of controls on disposal of substances was not perceived to be a problem until after the facts of damage began to accumulate. Health standards for contaminant substances are neither uniform nor widespread. The usual practice has been to adopt, rather arbitrarily, minimum levels that are somewhere near the cutting edge of our technical ability to detect. This practice seldom bears any realistic relationship to identified damage-causing levels. (See also W90-05169) (Lantz-PTT)
W90-05170

MODELING CONTAMINANT TRANSPORT IN GROUNDWATER: APPROACHES, CURRENT STATUS, AND NEEDS FOR FURTHER RESEARCH AND DEVELOPMENT.

Butler Univ., Indianapolis, IN. Holcomb Research Inst.

P. K. M. Van der Heijde.

IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 149-170, 7 tab, 14 ref.

Descriptors: *Research priorities, *Path of pollutants, *Groundwater pollution, *Model studies, *Solute transport, Groundwater movement, Water resources management, Flow pattern, Water chemistry.

Models are useful instruments in understanding the mechanisms of groundwater systems and the processes which influence their composition. Through their predictive capabilities, models provide a means to analyze the consequences of human intervention in groundwater systems. In managing water resources to meet long-term human and environmental needs, models are necessary tools. The application of models to groundwater pollution problems requires description of the systems initial conditions, characterization of its hydrogeology, definition of the relevant processes, and determination of the stresses on the system. In addition, management strategies need to be translated into modeling objectives and modeling scenarios. The objectives of this paper are to provide descriptions of: (1) the role of modeling in groundwater quality management, and (2) the current status of groundwater pollution modeling. This paper introduces various forms of directly and indirectly induced alterations in groundwater quality and reviews the relevant hydrodynamic transport processes along with the chemical and biological transformations active in groundwater, and their representation by models. Three types of models are frequently used in groundwater quality studies: flow models for the analysis of flow patterns and for the determination of streamlines, particle pathways, velocities, and traveltimes; solute transport models for the prediction of movement, concentrations, and mass balances of soluble constituents and for the calculation of radiological doses; and hydrochemical models, either equilibrium or kinetic, for the calculation of chemical constituent concentrations. The paper also addresses the need for modeling the potential impacts of proposed policies and options for corrective action. (See also W90-05169) (Lantz-PTT)
W90-05180

MOBILITY OF COLLOIDAL PARTICLES IN THE SUBSURFACE: CHEMISTRY AND HYDROLOGY OF COLLOID-AQUIFER INTERACTIONS.

Oak Ridge National Lab., TN. Environmental Sciences Div.

J. F. McCarthy.

Report No. DOE/ER-0425, October 4-6, 1988. 111p, 1 fig, 3 tab, 94 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Geohydrology, *Aquifers, *Colloids, *Water chemistry, Organic compounds, Inorganic compounds, Water pollution treatment, Chemical analysis, Bacteria, Viruses, Cleanup operations.

A meeting was held on October 4-6, 1989, in Manteo, North Carolina, to examine the chemical and hydrologic factors controlling the transport and deposition of organic and inorganic colloidal particles in subsurface environments. Sessions dealt with technical difficulties in sampling and characterizing colloidal particles in groundwater, and with observations of colloid movement in laboratory and field systems, with an emphasis on the chemical and hydrological factors controlling transport. Discussion sessions attempted to summarize the consensus of the group on two important issues: (1) identifying natural conditions that promote either the transport or the deposition of colloids, with the intent of focusing attention on those

subsurface environments with the greatest probability for the occurrence of mobile colloids, and (2) exploring strategies to manipulate colloid mobilization and deposition within subsurface systems to aid in remediation or mitigation of contamination at hazardous waste sites. Participants includes senior researchers from government research facilities and academic institutions in the United States, Canada, Germany, Switzerland, Sweden, and the United Kingdom. The primary problem in evaluating the significance of colloidal particles on contaminant transport centers on uncertainties in methods for sampling and characterizing groundwater colloids. While a number of valuable and innovative techniques were described, including a recent interlaboratory comparison of sampling and characterization methods, there still is no consensus on how well these methods reflect the true status of mobile colloidal particles that exist within natural groundwater systems. Several field studies provided strong evidence that colloidal particles do exist and are capable of transporting contaminants. Particularly strong evidence of colloid mobility is available for transport of biocolloids such as bacteria and viruses. (Lantz-PTT)
W90-05184

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS 1984-87.

Geological Survey, Tucson, AZ. Water Resources Div.

J. H. Eychaner, M. R. Rehmann, and J. G. Brown. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-410, 1989. 105p, 2 fig, 2 tab, 19 ref. Project AZ082.

Descriptors: *Groundwater pollution, *Mine wastes, *Acid mine drainage, *Arizona, Streamflow, Miami Wash, Pinal Creek, Water pollution sources.

Occurrence and movement of acidic contamination in the aquifer and streams of the Pinal Creek basin near Globe, Arizona, is the focus of an ongoing study by the U.S. Geological Survey. Groundwater data from that study for water years 1984 to 1987 include location, construction information, and site plans for six groups of monitoring wells, mineralogical and particle-size analyses of drill cuttings, water level measurements, and chemical analyses of water samples from 39 wells. Surface water data for 13 sites in this study include discharge measurements and chemical analysis of water and streambed sediment samples. Monthly discharge data are presented for one site. Monthly precipitation amounts and statistics of long-term precipitation are presented for two sites. (USGS)
W90-05187

GEOHYDROLOGY OF THE FOOTHILL GROUND-WATER BASIN NEAR SANTA BARBARA, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.

For primary bibliographic entry see Field 2F.
W90-05194

EVALUATION AND MODELING OF VOLATILE ORGANIC VAPOR TRANSPORT IN THE UNSATURATED ZONE FOR GROUNDWATER QUALITY PROTECTIONS.

Utah Water Research Lab., Logan.

R. R. Dupont, W. J. Doucette, R. Gan, and J. D. Doherty.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-119736/AS, price codes: A15 in paper copy, A01 in microfiches. Final Report, October 1989. 312p, 82 fig, 49 tab, 100 ref, 15 append. USGS Contract 14-08-0001-G1279.

Descriptors: *Model studies, *Computer models, *Fate of pollutants, *Groundwater quality, *Water quality control, *Volatile organic compounds, *Vapor transport, Hazardous wastes, Transport

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modeling. Organic compounds, Toxic substances, Underground storage, Storage tanks, Path of pollutants, Distribution coefficients.

The effects of hydraulics and temperature gradients on the emissions of hazardous organic vapors from soil systems were evaluated under a variety of initial and boundary conditions. To provide necessary environmental fate input data for transport modeling, laboratory investigations were undertaken to evaluate the effects of temperature on soil liquid transport coefficients and multiphase soil distribution constants. Distribution coefficient determinations were evaluated using multiphase versus two-phase, and single component versus multicomponent systems, and the feasibility and accuracy of computational methods for estimating multiphase/multicomponent distribution coefficients was investigated. A computer model was developed, which accounts for the effects of hydraulic and temperature gradients on volatile solute movement in soil systems, and laboratory column studies were used for model calibration and verification. As temperature increased, the mass of VOCs in the air and water phases increased, while the amount in the soil phase decreased. Temperature had a negligible effect on oil phase VOC concentrations over the temperature range from 4 to 35°C. The van't Hoff equation was not valid for all coefficients of interest in the study. Soil/water, air/soil and air/oil partition coefficients were highly correlated with both Molecular Connectivity Index (MCI) and Total Molecular Surface Area (TSA), and regression models were developed to estimate these partition coefficients from compound topological parameters. The saturated conductivity of the test soils varied with the bulk density and soil temperature. This soil temperature effect on saturated conductivity could not be explained solely by the change in viscosity of the wetting fluid with temperature. The saturated conductivity determined in a static temperature environment was statistically different from that measured using a dynamic temperature environment. (Dupont-Ut. St. V., UWRL)

W90-05200

PREDICTION OF GROUNDWATER FLOW AND MASS TRANSPORT USING LINEAR AND NONLINEAR ESTIMATION METHODS. Stanford Univ., CA. Dept. of Civil Engineering. For primary bibliographic entry see Field 2F.

W90-05201

TRENDS IN SELECTED WATER-QUALITY VARIABLES, FLATHEAD RIVER AT FLATHEAD, BRITISH COLUMBIA, AND AT COLUMBIA FALLS, MONTANA, WATER YEARS 1975-86.

Geological Survey, Billings, MT. Water Resources Div.

L. E. Cary.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4054, August, 1989. 34p, 1 fig, 5 tab, 11 ref.

Descriptors: *Water quality, *Surface water, *Flathead River, *Montana, *Water resources data, *British Columbia, Hydrologic data, Data collections, Statistical analysis.

Data for selected water quality variables were evaluated for trends at two sampling stations—Flathead River at Flathead, British Columbia (Flathead station) and Flathead River at Columbia Falls, Montana (Columbia Falls station). The results were compared between stations. The analyses included data from water years 1975-86 at the Flathead station and water years 1979-86 at the Columbia Falls station. The seasonal Kendall test was applied to adjusted concentrations for variables related to discharge and to unadjusted concentrations for the remaining variables. Slope estimates were made for variables with significant trends unless data were reported as less than the detection limit. At the Flathead station, concentrations of dissolved solids, calcium, magnesium, sodium, dissolved nitrite plus nitrate nitrogen, ammonia nitrogen (total and dissolved), total organic nitrogen, and total phosphorus increased during

the study period. Concentrations of total nitrite plus nitrate nitrogen and dissolved iron decreased during the same period. At the Columbia Falls station, concentrations increased for calcium and magnesium and decreased for sulfate and dissolved phosphorus. No trends were detected for 10 other variables tested at each station. Data for the Flathead station were reanalyzed for water years 1979-86. Trends in the data increased for magnesium and dissolved nitrite plus nitrate nitrogen and decreased for dissolved iron. Magnesium was the only variable that displayed a trend (increasing) at both stations. The increasing trends that were detected probably will not adversely affect the water quality of the Flathead River in the near future. (USGS)

W90-05206

GROUND-WATER AND SURFACE-WATER DATA FOR WASHINGTON COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.

For primary bibliographic entry see Field 7C.

W90-05207

APPRAISAL OF GROUND-WATER QUALITY IN THE BUNKER HILL BASIN OF SAN BERNARDINO VALLEY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.

For primary bibliographic entry see Field 2F.

W90-05211

WATER QUALITY OF LAKE AUSTIN AND TOWN LAKE, AUSTIN, TEXAS.

Geological Survey, Austin, TX. Water Resources Div.

For primary bibliographic entry see Field 7C.

W90-05212

ASSESSMENT OF PROCESSES AFFECTING LOW-FLOW WATER QUALITY OF CEDAR CREEK, WEST-CENTRAL ILLINOIS.

Geological Survey, Urbana, IL. Water Resources Div.

A. R. Schmidt, W. O. Freeman, and R. D. McFarlane.

Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4141, Jan. 1989. 79p, 24 fig, 15 tab, 15 ref.

Descriptors: *Water quality, *Dissolved oxygen, *Low flow, *Urban runoff, Waste assimilative capacity, Computer models, Illinois, Cedar Creek, Water pollution sources, Water pollution effects.

Water quality and the processes that affect dissolved oxygen, nutrient (nitrogen and phosphorus species), and algal concentrations were evaluated for a 23.8-mile reach of Cedar Creek near Galesburg, west-central Illinois, during periods of warm-weather, low-flow conditions. Water quality samples were collected and stream conditions were measured over a diel (24 hour) period on three occasions during July and August 1985. Analysis of data from the diel-sampling periods indicates that concentrations of iron, copper, manganese, phenols, and total dissolved-solids exceeded Illinois' general-use water quality standards in some locations. Dissolved-oxygen concentrations were less than the State minimum standard throughout much of the study reach. These data were used to calibrate and verify a one-dimensional, steady-state, water quality model. The computer model was used to assess the relative effects on low-flow water quality of processes such as algal photosynthesis and respiration, ammonia oxidation, biochemical oxygen demand, sediment oxygen demand, and stream reaeration. Results from model simulations and sensitivity analysis indicate that sediment oxygen demand is the principal cause of low dissolved-oxygen concentrations in the creek. (USGS)

W90-05223

MOVEMENT OF PESTICIDES AND NUTRIENTS INTO TILE DRAINAGE WATER.

Purdue Univ., Lafayette, IN. Dept. of Agronomy. G. E. VanScoyoc, and E. J. Klavivko.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129149/AS. Price codes: A05 in paper copy, A01 in microfiche. Final Completion Report, (1989). 89p, 1 fig, 17 tab, 26 ref, 3 append. USGS Contract 14-08-0001-G1127.

Descriptors: *Path of pollutants, *Subsurface drainage, *Pesticides, *Nutrients, Water pollution sources, Nitrogen, Leaching, Fertilizers, Herbicides, Insecticides, Contaminant transport, Adsorption, Drainage, Soil physics, Soil chemistry, Saturated flow, Unsaturated flow, Solute transport, Surface-groundwater relations, Ohio River Basin, Indiana, Jennings County, Agriculture, Water quality.

The objectives of this study were to determine field-scale pesticide and nutrient losses to tile drains over a 3-year period on a low organic matter, poorly structured silt loam soil (Fine-silty, mixed, mesic, Typic Ochraqualf) under typical agricultural management practices. A tile drainage spacing study was instrumented to measure water outflow rates and to collect tile outflow samples continuously on a flow-proportional basis. Two replicates of 3 tile spacings (5, 10, and 20 m) were included in the study. Water samples were analyzed for all applied pesticides (atrazine, cyanazine, alachlor, carbofuran, terbufos, and chlorpyrifos) as well as major nutrients (N,P,K) and sediment. Annual carbofuran losses in tile outflow ranged from 0.8 to 14.1 g/ha, or 0.05 to 0.94% of the amount applied to the soil. Carbofuran losses to tile drains were lowest for the widest tile spacing (20 m), probably indicative of greater sorption or degradation occurring during the longer travel times to the tile. Following spring pesticide application, carbofuran concentrations in the outflow increased after each new outflow event started, and they decreased as the flow event continued. Losses of all other pesticides were < or = 0.06% of the amount applied. Annual nitrate-N losses to tile outflow ranged from 18 to 74 kg/ha, with the greatest losses occurring from the narrowest tile spacing (5 m). The study was conducted in south-eastern Indiana on the Illinoian glacial till plain, and results would be applicable to many similar soils in southern Ohio, Indiana and Illinois. (USGS)

W90-05232

GROUNDWATER INVESTIGATION OF SO₄(2-) DIFFUSION FROM A CRETACEOUS SHALE HILLSLOPE: UPPER COLORADO RIVER BASIN.

Utah Water Research Lab., Logan.

C. J. Duffy, J. J. Jurinak, S. Korom, and P. Corey. Available from National Technical Information Service, Springfield, VA 22161 as PB90-129156/AS. Price codes: A08 in paper copy, A01 in microfiche. Completion Report, September 1989. 150p, 35 fig, 40 ref, 4 append. USGS Contract 14-08-0001-G1308.

Descriptors: *Colorado River Basin, *Slopes, *Hydrology, *Salinity, *Solute transport, *Shale, *Groundwater quality, Advection, Diffusion, Dispersion, Shallow aquifers, Water pollution sources, Path of pollutants, Saline soils, Model studies.

This research examines the role of advection, diffusion, and dispersion in the generation and transport of groundwater salinity from hillslopes to streams of the Upper Colorado River Basin. The study coordinated field experiments and theoretical-computer experiments to gain insight into the way that subsurface salinity fronts are mobilized and transported from hillslopes of the region, and to better understand the mechanics of the groundwater system within surficial deposits which generate the observed accumulation of salinity in the Colorado River system. The field situation is that excess irrigation water from snowmelt runoff infiltrates, generates a shallow saturated zone and ultimately produces stream salinization as return flow. The following two mechanisms are proposed: (1) The formation of a shallow aquifer and accelerated displacement of salts from alluvial sediments on the

Sources Of Pollution—Group 5B

lower portion of hillslopes. This displacement is a natural consequence of excess irrigation and canal seepage. (2) The diffusion of saline pore fluids from a low permeability marine shale which underlies the shallow aquifer. Since the marine, Mancos Shale, underlies most of the irrigated land of the basin, the potential for diffusive salt loading from this formation constitutes a major nonpoint source of downstream salinity. (USGS)
W90-05234

CORROSIVE GROUNDWATER IN THE KIRKWOOD-COHANSEY AQUIFER SYSTEM IN THE VICINITY OF OCEAN COUNTY, EAST-CENTRAL NEW JERSEY.

Geological Survey, Trenton, NJ. Water Resources Div.

For primary bibliographic entry see Field 2K.
W90-05275

COMPOSITION, DISTRIBUTION, AND HYDROLOGIC EFFECTS OF CONTAMINATED SEDIMENTS RESULTING FROM THE DISCHARGE OF GOLD MILLING WASTES TO WHITEWOOD CREEK AT LEAD AND DEADWOOD, SOUTH DAKOTA.

Geological Survey, Rapid City, SD. Water Resources Div.

K. E. Goddard.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4051, 1989. 76p, 20 fig, 14 tab, 31 ref.

Descriptors: *Water pollution sources, *Mine wastes, *Path of pollutants, *Water quality, Sediment chemistry, Geochemistry, Gold mines.

The Whitewood Creek-Belle Fourche-Cheyenne River stream system in western South Dakota has been extensively contaminated by the discharge to Whitewood Creek of about 100 million tons of mill tailings from gold-mining operations. The resulting contaminated sediments contain unusually large concentrations of arsenic, as much as 11,000 micrograms/g, derived from the mineral arsenopyrite, as well as potentially toxic constituents derived from the ore-body minerals or from the milling processes. Because of the anomalous arsenic concentrations associated with the contamination, arsenic was used as an indicator for a geochemically based, random, sediment-sampling program. Arsenic concentrations in shallow, contaminated sediments along the flood plains of the streams were from 1 to 3 orders of magnitude larger than arsenic concentrations in uncontaminated sediments in about 75% of the flood plains of Whitewood Creek and the Belle Fourche River. Appreciable surface-water contamination resulting from the contaminated sediments is confined to Whitewood Creek and a reach of the Belle Fourche River downstream from the mouth of Whitewood Creek. In Whitewood Creek, dissolved-arsenic concentrations vary from about 20 to 80 microgram/L during the year in response to variations in groundwater inflow and dilution, whereas total-recoverable-arsenic concentrations vary from about 20 to 8,000 micrograms/L during short periods in response to rapid changes in suspended-sediment concentration. Contamination of the alluvial aquifer along the stream system is limited to areas in direct contact with large deposits of contaminated sediments. Within the aquifer, arsenic concentrations are thought to be controlled by sorption-desorption on metallic hydroxides. (USGS)
W90-05277

EVALUATION OF THM PRECURSOR CONTRIBUTIONS FROM AGRICULTURAL DRAINS.

Arizona Univ., Tucson. Dept. of Civil Engineering.
G. L. Amy, J. M. Thompson, L. Tan, M. K. Davis, and S. W. Krasner.

Journal of the American Water Works Association JAWWA, Vol. 82, No. 1, p. 57-64, January 1990. 7 fig, 4 tab, 10 ref.

Descriptors: *California, *Trihalomethanes, *Irrigation effects, *Nonpoint pollution sources,

*Water pollution sources, *Agricultural water, Organic carbon, Peat, Humic acids, Drains, Organic halides.

More than 200 agricultural drains in the Sacramento River Delta contribute significant levels of trihalomethane (THM) precursors to California State Project water. It has been hypothesized that these drains, associated with crop irrigation involving highly organic peat soils, are probably responsible for the higher levels of dissolved organic carbon and THM formation potential in the California Aqueduct emanating from the delta in comparison with the principal freshwater tributaries entering the delta. Sample analyses showed that dissolved organic matter associated with drain samples exhibited much higher levels of THM formation potential than a series of related river and lake samples although a wide range in THM precursor levels was observed among the four agricultural drains sampled and analyzed. Dissolved organic matter in drain samples had a higher apparent molecular weight than that found in river and lake samples. The THMs produced represent only 30 percent of the total organic halides formed. Because future regulations will probably involve maximum contaminant levels for other disinfection byproducts, any increase in the reactivity of humic materials caused by agricultural drains could prove significant. (Author's abstract)
W90-05291

DISCHARGER GROUPING FOR WATER QUALITY CONTROL.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5G.
W90-05300

INTERACTION IN AQUEOUS SOLUTION OF CERTAIN PESTICIDES WITH FULVIC ACIDS FROM A SPODOSOL SOIL.

Instituto de Recursos Naturales y Agrobiología, Seville (Spain).

C. Maqueda, E. Morillo, and J. L. P. Rodriguez.
Soil Science SOSC, Vol. 148, No. 5, p. 336-345, Nov 1989. 11 fig, 1 tab, 21 ref.

Descriptors: *Pesticides, *Fulvic acids, *Path of pollutants, Chemical reactions, Spodosol, Precipitates, Amitrole, Chlordimeform, Diquat, Paraquat, Infrared spectroscopy.

Data on the interaction of fulvic acids (FA) extracted from a Spodosol soil, dissolved in water, with other aqueous solutions of various pesticides (amitrole, chlordimeform, diquat, and paraquat) in diverse concentrations were analyzed. A strong interaction was observed, precipitates appeared that were more abundant as greater concentrations of the pesticide were used. Both the weights of the precipitates obtained and the coloring of the equilibrium solutions indicate that some FA persist in solution in spite of an excess of pesticide. The quantity of precipitate followed the order: diquat > paraquat > Chlordimeform >> amitrole. The interaction mechanisms between the FA and the pesticides were determined by infrared spectroscopy. The adsorption of these pesticides by FA is a cation-exchange process to which are added H-bonding and charge-transfer mechanisms. (Author's abstract)
W90-05308

RESIDUES OF FLURIDONE AND A POTENTIAL PHOTOPRODUCT (N-METHYLFORMAMIDE) IN WATER AND HYDROSOIL TREATED WITH THE AQUATIC HERBICIDE SONAR.

Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab.

S. D. West, K. A. Langland, and F. B. Laroche.
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 38, No. 1, p. 315-319, January 1990. 4 fig, 4 tab, 11 ref.

Descriptors: *Fluridone, *Pesticide residues, *Degradation products, *Fate of pollutants, *Ponds, *Herbicides, *Methylformamide, *Aquatic soils, Chemical analysis, Path of pollutants, Water sampling, Biodegradation.

Fluridone is the active ingredient in the aquatic herbicide Sonar. Two ponds in Florida were treated with Sonar AS (an aqueous suspension formulation) and Sonar SRP (a slow-release clay pellet formulation). Both ponds were treated at the maximum acceptable residue level for fluridone in potable water, 0.15 ppm. The dissipation of fluridone and the potential formation of N-methylformamide (NMF) as a photolysis product of fluridone were monitored. Since NMF doses of greater than 10 mg/kg are known to produce a teratogenic response in pregnant rabbits, it was important to confirm that NMF was not present on ponds treated with commercial Sonar formulations. The fluridone concentration decreased to a nondetectable level (less than 0.001 ppm) in the water of both ponds 324 days after treatment (DAT). NMF was not detected in any of the 192 water samples that were collected on any of the sampling dates at a detection limit of 0.002 ppm. Hydrosoil samples collected at 324 DAT in both ponds contained fluridone residues equivalent to 2.9 to 3.6% of the amount applied to the pond, but no NMF was detected in the hydrosoil at a detection limit of 0.005 ppm. (Author's abstract)
W90-05326

BIOACCUMULATION OF CINMETHYLIN IN BLUEGILL SUNFISH.

Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Agricultural Products Dept.

For primary bibliographic entry see Field 5C.
W90-05327

LEAD IN THE BOTTOM SEDIMENTS OF LAKE NUNAGUAGA AND FOURTEEN OTHER BODIES OF WATER IN LUZERNE COUNTY, PENNSYLVANIA.

Wilkes Coll., Wilkes-Barre, PA. Dept. of Earth and Environmental Sciences.

J. M. Case, C. B. Reif, and A. Timko.

Journal of the Pennsylvania Academy of Science, Vol. 63, No. 2, p. 67-72, 1989. 3 fig, 3 tab, 22 ref.

Descriptors: *Sediment contamination, *Pennsylvania, *Lead, *Lake sediments, *Water pollution sources, Air pollution, Ponds, Lake Nunaguaga, Atomic adsorption spectrophotometry, Luzerne County.

The discovery of unexpectedly high lead content in bottom sediments of Lake Nunaguaga prompted the examination of sediments in nine other lakes and five ponds in Luzerne County, Pennsylvania. The lead values in surface sediments ranged from 22-407 micrograms per gram. A core from the bog adjacent to Lake Nunaguaga revealed elevated lead concentrations in the bog mat which decreased rapidly with increasing depth in the top 100 centimeters. Concentrations of lead in the underlying organic and limnetic deposits ranged from 6 to 18 micrograms per gram, which is consistent with core samples taken from the soil profiles in the watersheds of two lakes. Lead values were 7 micrograms per gram in bedrock, 55 in exposed soil, and 74 in the duff above the soil. Pond sediments showed lower concentrations of lead than lake sediments with a significant, positive linear correlation to the age of the pond. Analyses were done by standard atomic absorption spectrophotometry. From the values presented herein, it is suggested that the origin of the lead in these lake sediments is not from parent materials in the watershed but rather from transport of anthropogenic lead through the atmosphere. (Author's abstract)
W90-05335

MERCURY CONCENTRATIONS OF PERCH, PERCA FLUVIATILIS L., IN SMALL FINNISH HEADWATER LAKES WITH DIFFERENT PH AND WATER COLOUR.

Helsinki Univ., Lammi (Finland). Lammi Biological Station.

T. Metsala, and M. Rask.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p. 41-46, 1989. 3 fig, 2 tab, 34 ref.

Descriptors: *Fish physiology, *Path of pollutants, *Bioaccumulation, *Perch, *Mercury, *Aluminum,

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

Decomposing organic matter, Hydrogen ion concentration, Optical properties, Opacity, Humic acids, Color.

Mercury concentrations of perch were determined from 11 Finnish headwater lakes covering a pH range of 4.4-6.8 and water color range of 5-260 mg Pt/L. In a small humic pond, the mercury concentrations were significantly correlated with age and the total length of perch. The concentrations were 0.1-0.2 mg mercury/kg wet weight for 5-7 cm long, one summer-old individuals, and 0.5-0.6 mg mercury/kg wet weight for 20-25 cm long, eight year old individuals. In acidified, clearwater lakes, the mean mercury concentrations of perch after length correction were higher (0.3-0.6 mg mercury/kg wet weight) than in a circumneutral clearwater lake (0.1 mg mercury/kg wet weight). However, the mean mercury concentrations of perch in the 11 lakes did not correlate significantly with the pH of water. Mercury levels in humic lakes (0.4-0.8 mg mercury/kg wet weight, length corrected) were significantly higher than in clear lakes (0.1-0.6 mg mercury/kg). Total aluminum concentration was, however, the best univariate predictor for mercury enrichment in perch. (Author's abstract) W90-05342

CORRELATION AMONG THE TERRESTRIAL GAMMA RADIATION, THE INDOOR AIR 222RN, AND THE TAP WATER 222RN IN SWITZERLAND.

Paul Scherrer Inst., Wuerenlingen (Switzerland). Radiation Hygiene Div.
R. Buchli, and W. Burkart.
Health Physics HLTPAO, Vol. 57, No. 5, p 753-759, 1989. 5 fig, 2 tab, 16 ref. Swiss Federal Office for Energy Research grant no. 0.805.391.0216.

Descriptors: *Gamma radiation, *Subsoil, *Drinking water, *Public health, *Switzerland, *Radon, Radon gas, Correlation analysis, Soil contamination.

The external gamma radiation and the indoor air Radon (Rn) (222Rn) concentration were measured in 55 houses of the South East Grisons, the Urseren valley, and the Upper Rhine valley (crystalline subsoils) and in 39 houses of the Molasse basin and the Helvetic nappes (sedimentary subsoils). In homes located on crystalline subsoil, a mean cellar gamma level of 1.4 mGy/y was measured, which is twice the mean gamma level of 0.7 mGy/y found in homes built on sedimentary subsoil. The cellar 222Rn gas concentration is about six times higher in houses with a crystalline subsoil (1232 Bq/cu m) than in houses with a sedimentary subsoil (201 Bq/cu m). Although a weak correlation is observed between the mean gamma radiation levels and mean cellar 222Rn gas concentrations for the five subregions investigated, the gamma radiation and the 222Rn gas concentrations do not correlate for single homes. For the population living on the ground floor of a house with crystalline subsoil, the gamma radiation and the indoor air 222Rn lead to estimated mean exposures of 1.6mSv and 9.44 mSv effective dose equivalent per year, respectively. A mean tap water 222Rn content of 38.3 Bq/L and 10.4 Bq/L was measured in 31 villages with a crystalline subsoil and 73 villages with a sedimentary subsoil, respectively. Radon-222 degassing from the tap water into the indoor air leads to an additional exposure of about 0.11 mSv/y and 0.03 mSv/y in homes with a crystalline subsoil and homes with a sedimentary subsoil, respectively. (Author's abstract) W90-05365

RADIUM-226 CONTENT OF BEVERAGES.

Giessen Univ. (Germany, F.R.). Strahlenzentrum. J. Kiefer.
Health Physics HLTPAO, Vol. 57, No. 5, p 761-763, 1989. 3 fig, 1 tab, 9 ref.

Descriptors: *Radium, *Radioisotopes, *Public health, Mineral water, Drinking water, Beer, Wine, West Germany.

Radium contents of commercially obtained beer, wine, milk and mineral waters were measured. All

distributions were log-normal with the following geometrical mean values: beer: 0.021 Bq/L; wine: 0.034 Bq/L; milk: 0.003 Bq/L; normal mineral water: 0.043 Bq/L; medical mineral water: 0.094 Bq/L. (Author's abstract) W90-05366

EFFECT OF REDOX POTENTIAL ON FIXATION OF 137 CESIUM IN LAKE SEDIMENT.

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
J. H. Pardue, R. D. Delaune, W. H. Patrick, and J. H. Whitcomb.

Health Physics HLTPAO, Vol. 57, No. 5, p 781-789, 1989. 7 fig, 4 tab, 19 ref.

Descriptors: *Path of pollutants, *Cesium, *Lake sediments, *Cesium radioisotopes, Ion exchange, Isotope studies, Ammonium, Sodium, Clays, Oxidation-reduction potential.

Fixation of 137Cs (Cs = cesium) was determined in lake sediment suspensions under controlled redox potentials in the laboratory. The activity of previously added 137Cs on various clay sites was determined by time-series selective extractions. Monovalent cations, particularly NH4(+), were much more effective at displacing 137Cs than divalent cations or Na(+). Ammonium ion (NH4+) and Na(+) were used to extract 137Cs from selective and non-selective 137Cs binding sites, respectively. The activity of water-soluble 137Cs and Na-extractable 137Cs was significantly higher under anaerobic redox conditions (-200mV), when soluble NH4(+) concentrations in the anaerobic suspensions were 1000 microM or higher. Activities of 137Cs were highest (initially 40-50% of the 137Cs added) on the NH4(+)-extractable site. Over the long term, activities of NH4(+)-extractable 137Cs decreased linearly to below 10% as 137Cs was fixed on inter-lattice sites. Water-soluble 137Cs was significantly correlated with Na-extractable 137Cs in short-term experiments, suggesting the existence of an equilibrium between the different clay sites. High concentrations of NH4(+) under anaerobic redox conditions could shift this equilibrium, resulting in increases in water-soluble 137Cs and increases in the activities of 137Cs bound on non-selective clay sites. Additional studies are necessary to evaluate the interaction of 137Cs with sulfides, iron oxides, and other reactive chemical species which may attenuate 137Cs in sediment. (Author's abstract) W90-05367

ROLE OF VARIOUS MICROORGANISMS ON TC BEHAVIOR IN SEDIMENTS.

Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Lab. de Physiologie Vegetale. L. Pignolet, F. Auvray, K. Fonsny, F. Capot, and Z. Moureau.

Health Physics HLTPAO, Vol. 57, No. 5, p 791-800, 1989. 7 fig, 3 tab, 28 ref. Belgian Ministry of Labour, C.S.T. no. 20516, Commission of the European Communities CEC contract no. B-16-0049-B(TT).

Descriptors: *Path of pollutants, *Technetium, *Bacterial physiology, *Radioisotopes, *Biological magnification, *Marine bacteria, Isotope studies, Oxidation-reduction potential, Polysaccharides.

Marine bacteria (*Moraxella* sp., *Planococcus* sp. and a mixed population of anaerobes) from a coastal sediment were found to concentrate Technetium (Tc). Maximum concentration of this element occurred during the stationary phase of growth of the bacteria, at low redox potential. A metabolic process seems responsible for Tc concentration by bacteria, in which it binds to high molecular weight cellular constituents. Polysaccharidic polymers, which were visualized around the bacterial cells with the scanning electron microscope, might bind Tc, but direct experimental evidence in favor of this hypothesis was not yet obtained. It is suggested that sedimentary bacteria may serve to transfer radionuclides to higher trophic levels. However, no biomagnification of Tc has been reported in recent studies. Sulfate reducing bacteria may also play an important role in the disappearance of Tc from the solution through concentra-

tion of Tc by the bacteria themselves and through the formation of insoluble material. (Author's abstract) W90-05368

MICROBIOLOGY OF BOTTLED NATURAL MINERAL WATERS.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.

D. J. Stickler.

Journal of the Royal Society of Health JRSJSHS, Vol. 109, No. 4, p 118-124, 1989. 28 ref.

Descriptors: *Natural waters, *Mineral water, *Public health, Microbiological studies, Monitoring, Water quality standards, Contamination.

The microbiological flora content of mineral water is discussed with regard to regulations and practices that are intended to safeguard consumers from any danger of infection. At source, a natural mineral water will have a small population of essentially dormant or starved bacteria. As the water emerges from the underground source, proceeds through bottling and eventually to storage on retailer's shelves, there is a possibility of contamination of the water and changes in the state of these autochthonous flora. Under the Natural Mineral Water regulations passed by the U.K. Ministry of Agriculture, Fisheries and Food (MAFF 1985), applications to gain recognition for a natural mineral water have to provide a hydrogeological description of the source, including its exact location, altitude, and a detailed account of the geology of the surrounding terrain. The application must also include a detailed description of the site of the source, nature of equipment used for extracting the water, and measures taken to protect emerging waters from pollution. Required data on the chemical and physical characteristics of the water include: flow rates, temperature at emergence, dry residue content, electrical conductivity, pH, concentration of cations and anions, total organic carbon, free CO2 and radioactivity. Evidence that the water does not contain toxic concentrations of arsenic, cadmium, cyanide, chromium, mercury, nickel, antimony, selenium, or lead is also required. Required microbiological analysis includes: the demonstration of the absence of parasites and pathogenic organisms; quantitative determination of the indicators of fecal contamination; and determination of the total viable colony count per ml of water. To ensure that the required high standards are met, several clarifications regarding these regulations are needed. They include: that the microbiological data on the water has been produced by an independent authorized laboratory, using standard methods of analysis; that the laboratory sought the presence of parasites and pathogens and did not just infer their absence from the results of tests for bacterial indicators; and that the requirements to show that composition, temperature, and other essential characteristics remain stable within limits of natural fluctuation include microbiological characteristics of the water. (Male-PTT) W90-05374

USE OF ROOTS TRANSFORMED BY AGRO-BACTERIUM RHIZOGENES IN RHIZOSPHERE RESEARCH: APPLICATIONS IN STUDIES OF CADMIUM ASSIMILATION FROM SEWAGE SLUDGES.

Institut National de la Recherche Agronomique, Versailles (France). Lab. de Biologie de la Rhizosphere.

For primary bibliographic entry see Field 7B. W90-05382

AEROMONAS SPP. AND PLESIOMONAS SHIGELLOIDES IN BIVALVES, MUD, AND WATER OF THE GULF OF NICOYA, COSTA RICA.

Costa Rica Univ., San Jose. Facultad de Microbiologia.

E. Rodriguez, and F. Antillon.

Revista de Biologia Tropical RBTCAP, Vol. 37, No. 1, p 69-73, June 1989. 3 fig, 25 ref. Proyecto no. 430-86-022 Vicerrectoria de Investigacion Universidad de Costa Rica.

Sources Of Pollution—Group 5B

Descriptors: *Public health, *Contamination, *Costa Rica, *Mollusks, Infection, Pathogenic bacteria, Gulfs, Swimming, Foods, Culturing techniques, Water pollution, Sediment contamination.

Bivalves, mud, and surface water were collected at three different sites of the Gulf of Nicoya, Costa Rica, in search of *Aeromonas* spp. and *Plesiomonas shigelloides*. For their isolation, these bacteria were enriched in alkaline peptone water and streaked on MacConkey agar and on brilliant green bile inositol agar. This was followed by the chemical tests necessary for their identification. Thirty-five strains of *A. Hydrophila*, 58 of *A. caviae*, 43 of *A. sobria*, and 7 of *P. shigelloides* were isolated. None of these predominated nor was there any indication of seasonal distribution along the 15 month's duration of the study. Seven strains of *A. hydrophila* and two of *A. sobria* showed the biochemical characteristics of toxin production (positive Voges-Proskauer and lysine decarboxylase tests). These species are widely distributed in the gulf and there is risk of contracting an infection while bathing or when eating raw bivalves from this area. (Author's abstract)
W90-05383

CHEMISTRY OF HIGH MOUNTAIN LAKES IN SILICEOUS CATCHMENTS OF THE CENTRAL EASTERN ALPS.

Institut fuer Limnologie, Mondsee (Austria).
For primary bibliographic entry see Field 2H.
W90-05386

SEASONAL DYNAMICS OF A CYANOBACTERIA-DOMINATED MICROBIAL COMMUNITY IN SURFACE SEDIMENTS OF A SHALLOW, EUTROPHIC LAKE.

Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 2H.
W90-05387

STATE OF POLLUTION IN THE MARINE ENVIRONMENT.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
For primary bibliographic entry see Field 5C.
W90-05404

RADIONUCLIDES AND LARGE PARTICLES IN ESTUARINE SEDIMENTS.

Phoenix Research Lab., Tavistock (England).
E. I. Hamilton.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 603-607, December 1989. 2 fig, 1 tab, 12 ref.
European Economic Community Contract B16-B-038-UK.

Descriptors: *Marine sediments, *Radioactive wastes, *Irish Sea, *Radioisotopes, *Path of pollutants, *Particulate matter, Plutonium radioisotopes, Americium radioisotopes, Geochemistry, Radioactive wastes, Organic matter, Uranium radioisotopes, Estuaries, Iron, Esk Estuary, Manganese.

The distribution of radionuclides in the Esk estuary 10 km south of the British Nuclear Fuels plc (BNF) was surveyed in 1982 using portable NaI(Tl) and hyper-pure Ge(Li) detectors coupled to multi-channel analyzers. Radionuclides, released into the north-east Irish Sea from the BNF uranium reprocessing plant and which are present in sediments of the Esk estuary, Cumbria, were found to be initially associated with large (> 0.5 mm) rather than fine grained (< 63 micrometers) particles. These macro particles, termed organoliths, consist of an agglomerate of sediment grains held together with an organic iron rich matrix; their surfaces are coated with a patina of iron and manganese oxides with which the radionuclides are associated. Concentration factors (K_d's) for plutonium, americium, and other radionuclides, together with various stable elements in the patina are orders of magnitude greater than those found in bulk sediments. The organoliths are probably formed by an empty animal burrow becoming infilled with sand grains. Following tidal scouring the surface oxidized floc is removed leaving the

Fe-Mn oxide cemented walls of the burrow above the surface of the sediment. During the ebb flow high energy currents shear off the protruding cemented burrow. After release the detached portion of the burrow becomes rounded through water action. The presence of organoliths in Esk sediments which are enriched in radionuclides relative to bulk sediments has a bearing upon the use of K_d factors and also sequential leaching techniques. The presence or absence of organoliths could influence the gross specific radioactivity of fine grained sediment at a particular time when they are being formed, hence the apparent uptake of radionuclides in the Esk fine-grained sediments is likely to be associated with the concentration and stability of organoliths within the sediment rather than matters related simply to the surface properties of minerals which form the sediments. (Geiger-PTT)
W90-05405

UNUSUAL GRAIN SIZE EFFECT ON TRACE METALS AND ORGANIC MATTER IN CONTAMINATED SEDIMENTS.

Israel Oceanographic and Limnological Research Ltd., Haifa.
B. S. Krungal.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 608-611, December 1989. 2 fig, 18 ref.

Descriptors: *Sediment contamination, *Path of pollutants, *Particle size, *Cadmium, *Copper, *Lead, *Zinc, *Iron, Organic matter, Trace metals, Marine sediments, Path of pollutants, Spatial distribution, Haifa Bay, Israel, Adsorption.

Grain size effect on trace metals (cadmium, copper, lead, zinc, and iron) and total organic content distribution in various fractions (< 0.063, 0.063-0.105, 0.105-0.250, 0.250-0.500, and 0.500-1.000 mm) of contaminated sediment collected from Haifa Bay, Israel was studied. Selective partitioning of the studied contaminants in sediment fractions was observed, with a minimum content in the fine sand fraction of grain size 0.125-0.250 mm. Anomalously high concentrations of trace metals and organic matter content in the medium and coarse sediment fractions (> 0.250 mm) was explained by the formation of large agglomerates (clusters) during the generally recommended drying procedures. These large agglomerates, formed from smaller sediment fraction particles enriched by various contaminants kept on their large specific area by adsorption forces, have been observed in photographs of the medium and coarse sediment fractions only. The formed agglomerates consist of small particles cemented either by dissolved organic matter or by sea salts present in the marine sediment. The formation of such agglomerates should be taken into consideration when conducting metal contamination studies on sediments. (Author's abstract)
W90-05406

BIOLOGICAL AND CHEMICAL COMPOSITION OF BOSTON HARBOR, USA.

Army Engineer Div. New England, Waltham, MA.
W. A. Hubbard, and R. J. Bellmer.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 615-621, December 1989. 1 fig, 5 tab, 25 ref.

Descriptors: *Pollution load, *Boston Harbor, *Baseline studies, *Aquatic animals, *Water pollution sources, Bays, Benthos, Monitoring, Oxygen requirements, Fish, Marine sediments, Dissolved oxygen, Metals, Environmental effects, Ecological effects, Water pollution effects, Wastewater pollution, Polychlorinated biphenyls, Mystic River.

As part of a planning study of improvements to the navigation channels in Boston Harbor, biological and chemical composition were determined during 1985 and 1986. Sampling of the sediments and water column involved 21 sediment chemistry stations, 13 benthic infaunal stations, and 6 otter trawl and gill net stations. The chemical determinations showed high levels of contaminations in the inner channels. Mystic River sediments contained high levels of polychlorinated biphenyls, volatile solids, lead, arsenic, zinc, and vanadium, and moderate levels of oil and grease, mercury, copper, chromi-

um, and nickel. Chelsea River sediments contained elevated levels of contaminants (lead) at 2 of 8 stations. The benthic organism populations reacted to the sediment chemical stress and a seasonal oxygen depletion with episodes of tolerance and defaunation. Lowest dissolved oxygen levels were recorded in August (1.3 ppm). The finfish species followed a similar pattern as the infaunal community. The proposed switch from primary to secondary sewage treatment for Boston Harbor may allow the Mystic River to become a particularly contaminated pathway if a sere shift occurs. (Geiger-PTT)
W90-05408

LEVELS OF HEAVY METALS ALONG THE LIBYAN COASTLINE.

Trinity Coll., Dublin (Ireland). Environmental Sciences Unit.
M. S. Hamouda, and J. G. Wilson.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 621-624, December 1989. 2 fig, 3 tab, 7 ref.

Descriptors: *Heavy metals, *Libya, *Coastal waters, *Marine sediments, *Pollution load, *Path of pollutants, Bays, Cadmium, Copper, Zinc, Nickel, Manganese, Organic matter, Calcium carbonate, Water pollution sources.

A coastal survey off the east part of the Libyan coastline which has no river inputs was initiated to measure the existing level and distribution of selected heavy metals (Cu, Zn, Cd, Ni, and Mn) in surface sediments along Benghazi Bay. The results, compiled using the pollution load index (PLI), establish that of the sites examined only the harbor site exhibited relatively high levels particularly in the cases of cadmium and copper indicating a detectable anthropogenic input. The range of concentrations were 1.03-1.96% micrograms/gm (dry wt) for organic content and 64.7-93% for calcium carbonate while the range of heavy metals concentrations (micrograms/gm dry wt) were 8.7-42 for Cu, 2.3-27.3 for Zn, 5.7-19 for Ni, 37-76.7 for Mn, and below the detection limit of 1.73 for Cd. A PLI score of 2.93 was obtained at the harbor site and a range of 6.11-7.63 for the other sites. The PLI score for the control site was 9.51 and the score for the overall studied area was 7.51 indicating a very clean environment. The index would be, with some modification, a step in the right direction from the management point of view in Libya due to the absence of environmental expertise. (Author's abstract)
W90-05409

ALTERATION OF PHOSPHORUS DYNAMICS DURING EXPERIMENTAL EUTROPHICATION OF ENCLOSED MARINE ECOSYSTEMS.

Rhode Island Univ., Narragansett. Marine Ecosystems Research Lab.
For primary bibliographic entry see Field 5C.
W90-05410

DDT RESIDUES IN FISHES FROM THE EASTERN ARABIAN SEA.

National Inst. of Oceanography, Panaji (India).
M. S. Shailaja, and R. Sen Gupta.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 629-630, December 1989. 1 fig, 1 tab, 6 ref.

Descriptors: *DDT, *Pesticide residues, *Arabian Sea, *Fate of pollutants, *Fish, *DDE, DDD, Chlorinated hydrocarbons, Water pollution effects, Bioaccumulation.

Samples of fish from the coastal waters and open ocean of the Arabian Sea were analyzed for residues of DDT, DDE, DDD, and trace organochlorines in whole body, muscle or liver samples by gas chromatography. Results indicate that the metabolites of DDT are ubiquitous in the samples analyzed; p,p'-DDE was the most frequently detected DDT metabolite, and was present in 60% of the coastal and 75% of the open ocean fish samples. Its concentration ranged from 14.89-36.62 nanograms/gm wet wt in the coastal samples and from traces to 50.42 nanograms/gm in the open

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ocean samples. p,p'-DDD was found in three out of nine samples and was the only other metabolite of DDT detected. Trace amounts of hexachlorobenzene, isomers of HCH and 1-hydroxychlorodene were found in the open ocean fish. The presence of a high proportion of DDE in relation to the total DDT burden in the tissue of the fish sampled indicates that migratory species can convert DDT rapidly to its metabolites because of high metabolic rates or this area in the Arabian Sea is not threatened by new inputs of DDT. (Geiger-PTT) W90-05411

LEVELS OF HEAVY METALS IN SOME RED SEA FISH BEFORE HOT BRINE POOLS MINING.

State Pollution Control Commission, Sydney (Australia).

R. G. M. Hanna.

Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 12, p 631-635, December 1989. 1 fig, 3 tab, 16 ref.

Descriptors: *Heavy metals, *Red Sea, *Chemical analysis, *Pollutant identification, *Fish, *Fate of pollutants, *Baseline studies, Copper, Cadmium, Zinc, Lead, Tissue analysis, Cobalt, Nickel, Chromium, Manganese, Trace metals, Atomic absorption spectrophotometry.

The concentrations of copper, cadmium, zinc, lead, manganese, cobalt, nickel, and chromium were determined in muscle, liver, and gonads of Red Sea Fish collected from the littoral areas of Ras-Gharib in the northern Egyptian Red Sea to Ras Bonas in the south of the Egyptian Red Sea during 1980 and 1982. Levels of the metals were determined by atomic absorption spectrometry as part of a baseline study before the initiation of hot brine pools mining in the area. The range of concentrations found fell generally within the range of concentrations reported for these elements in marine fish by previous investigators. The levels of Cu, Cd, Zn, Co, and Pb in liver were relatively higher than in muscle. High values for Zn were noted, one of 611.5 micrograms/gm dry wt for liver from *Siganus oramin*, the second of 520.2 micrograms/gm dry wt for liver from *Odonus niger*, the third of 792.4 micrograms/gm dry wt for gonad from *Balistoides viridescens*. Most coral-feeder species had low concentrations of Cu, Cd, Zn, and Ni in their muscle and liver tissues, while some bottom carnivorous fish which feed on crustaceans and mollusks had maximum mean concentrations of Zn, Co, Ni, and Cr. Cu and Cd concentrations in muscle tissues of *Siganus oramin*, *Lethrinus genivittatus* and *L. harak* decrease with increasing age, but for *Variola louti* increase with increasing age. Zn concentrations in *Siganus oramin* muscle and liver tissues decrease with increasing age, but in other species increase with increasing age. No clear trends were observed between metal concentrations and site or seasonal changes. (Geiger-PTT) W90-05412

METAL FLUXES TO SWEDISH FOREST LAKES.

National Swedish Environment Protection Board, Solna. Trace Metal Lab.

H. Borg, and K. Johansson.

Water, Air and Soil Pollution WAPLAC, Vol. 47, No. 3-4, p 427-440, October 1989. 1 fig, 2 tab, 78 ref.

Descriptors: *Forest hydrology, *Acid rain effects, *Heavy metals, *Lakes, *Sweden, *Runoff, *Water pollution sources, Path of pollutants, Hydrogen ion concentration, Forest watersheds, Forest soils, Soil chemistry, Acidic water, Zinc, Cadmium, Copper, Lead, Mercury, Humic acids, Air pollution.

Data on atmospheric deposition, transport via runoff water and contents in soil were used to estimate the fluxes of Zn, Cd, Cu, Pb, and Hg to Swedish forest lakes. The calculations refer to a hypothetical lake with a surface area of about 9% of the total catchment area. There are clear differences in the pathways and transport mechanisms for the different elements. The dominating pathway for the input of Zn and Cd to lakes is via runoff from the drainage area. About 60 to 95% of

the total load comes from runoff, highest in the acidified areas. The acidification status of the soil is by far the most important factor regulating the mobility of these elements. The amounts of Hg and Pb deposited on the drainage area are mainly accumulating in the surficial soil layers. The transport of these elements is primarily associated with humic substances. About 30 to 50% of the total load of Pb and 25 to 75% of the total load of Hg to lakes originates from runoff. The transport mechanisms for Cu are similar to those of Pb and Hg, but due to the lower anthropogenic airborne load, the direct deposition is of less importance. (Author's abstract) W90-05414

METALS IN SEDIMENT OF LAKES IN NORTHERN SWEDEN.

National Swedish Environment Protection Board, Solna. Research Dept.

K. Johansson.

Water, Air and Soil Pollution WAPLAC, Vol. 47, No. 3-4, p 441-455, October 1989. 2 fig, 4 tab, 31 ref.

Descriptors: *Heavy metals, *Lake sediments, *Sweden, *Path of pollutants, *Forest watersheds, Cadmium, Zinc, Lead, Copper, Iron, Water pollution sources, Spatial distribution.

The concentrations of Pb, Cu, Zn, Cd, and Fe were measured in sediment from 54 soft water lakes in the inland part of central and northern Sweden in order to study the regional impact of metals to lakes. An evident regional distribution due to environmental pollution was found concerning Pb, Cd, Zn, and Cu. In the southern part of the studied region, the enrichment factors in the top sediment layers were about 50, 7, 4, and 2, for Pb, Cd, Zn, and Cu, respectively. Further to the north, the contamination of the top sediments gradually decreased. In a large part of the northern region, the sediment analyses showed no general vertical gradients of Zn and Cu, indicating non-polluted conditions. Lead was the most widespread and pronounced pollutant with marked enhancements in most parts of the region. In the northernmost areas, the top sediment showed increased concentrations of Pb and Cd of about a factor of 2, suggesting that strictly non-polluted conditions concerning these two metals can not be found anywhere in the studied region. The regional distribution of Fe differed from the other metals and gave no evidence of a large-scale anthropogenic contribution. The natural enrichment of Pb, Cu, Zn, and Cd in the surface sediment is probably of minor importance in these kinds of lakes. The regional distribution of metals in sediments indicate that there is a large scale impact of Pb, Cd, Zn, and Cu on Swedish forest lakes, caused by anthropogenic factors. (Author's abstract) W90-05415

ANALYSIS OF GROUNDWATER POLLUTION WITH ATRAZINE (UNTERSUCHUNGEN ZUR GRUNDWASSERBELASTUNG MIT ATRAZIN).

Technische Univ., Munich (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.

M. Grandet, K. E. Quentin, and L. Weil.

Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 231-235, December 1989. 5 fig, 5 tab, 14 ref. English summary.

Descriptors: *Agricultural chemicals, *Groundwater pollution, *Atrazine, *Pesticide residues, *Path of pollutants, Soil contamination, Herbicides.

Soil samples from atrazine treated corn fields were analyzed for the vertical distribution of atrazine and metabolites in soil at depths of 0-20 cm; 20-40 cm and 40-60 cm. The soil samples were eluted with distilled water and atrazine and metabolites were analyzed in the eluate. Ninety-four percent of atrazine was retained in the first 20 cm of the soil. The concentration of atrazine in the upper soil layer decreased in the first 3.5 mo to 1/17, and in 9 mo to 1/36 of the initial concentration. Atrazine concentration in groundwater varied from 0.56 to 3.68 microgram/L while desethyl atrazine varied from 0.15 to 0.667. (Geiger-PTT)

W90-05416

USE OF BIODETECTORS AS 'CHANNEL SPY' TO ENCIRCLE NON-LEGAL HEAVY METAL DISCHARGES IN SEWERS (EINSATZ EINES BIODETEKTORS ALS KANALSPION ZUM NACHWEIS DER SCHWERMETALLHERKUNFT IN ABWASSERSIELEN).

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.

For primary bibliographic entry see Field 5A.

W90-05418

EVIDENCE OF DEPOSITION OF ATMOSPHERIC POLLUTANTS IN A REMOTE HIGH ALPINE LAKE IN AUSTRIA.

Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).

C. Steinberg, W. Kalbfus, M. Maier, and K. Traer. Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 245-248, December 1989. 7 fig, 1 tab, 16 ref.

Descriptors: *Water pollution sources, *Lake sediments, *Air pollution, *Acid rain effects, *Austria, *Aromatic compounds, Alpine regions, Lakes, Path of pollutants.

In a 34 cm long sediment core from a remote, high elevation lake of the central Austrian Alps, the chronology of six polycyclic aromatic hydrocarbons (fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene) was studied by high performance liquid chromatography. All of the polycyclic aromatic hydrocarbons showed maximum concentrations at the sediment surface, indicating increasing depositions of these compounds. For benzo(b)fluoranthene, benzo(a)pyrene and fluoranthene a biotic and/or diagenetic origins cannot be totally excluded. If biotic and/or diagenetic polycyclic aromatic hydrocarbons are negligible, the concentrations of these organic pollutants in the sediments of remote lakes are influenced by the amount of atmospheric deposition, the loss through volatilization, and the organic carbon content of the sediment material. For remote lakes of the world, the background concentration of fluoranthene ranges between 80 and 375 nanograms/gm. (Author's abstract) W90-05419

STREAMING CURRENT DETECTION FOR DETERMINATION OF METAL COMPLEXATION CAPACITIES OF AQUATIC HUMIC SUBSTANCES.

Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.

For primary bibliographic entry see Field 5A.

W90-05421

LYSIMETER EXPERIMENTS ON THE CORRELATION OF THE INCREASE OF NITRATE CONCENTRATION AND HARDNESS IN GROUNDWATER (LYSIMETERVERSUCHE UEBER DEN ZUSAMMENHANG DES ANSTIEGES DER NITRATKONZENTRATION UND DER HAERTE IM GRUNDWASSER).

Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Radiochemie.

S. H. Eberle, and M. Maier.

Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 262-267, December 1989. 7 fig, 10 ref. English summary.

Descriptors: *Water pollution sources, *Lysimeters, *Nitrogen, *Forest soils, *Nitrates, Leachates, Hardness, Calcium, Magnesium, Path of pollutants, Groundwater pollution.

The oxidative transmutation of organic nitrogen in forest soil was investigated by lysimeter experiments and with Kick-Brauckmann vessels. The concentration of nitrate and the hardness in the leachates showed a good correlation and are interpreted as the presence and formation respectively of calcium nitrate and magnesium nitrate. Examples are given of groundwater analyses which

show the same simultaneous increase of nitrate concentration and hardness over long time periods and which prove it to be a common problem. (Author's abstract)
W90-05423

ATTACHMENT OF TOXIGENIC VIBRIO CHOLERA 01 TO VARIOUS FRESHWATER PLANTS AND SURVIVAL WITH A FILAMENTOUS GREEN ALGA, RHIZOCLONIUM FONTANUM.

London School of Hygiene and Tropical Medicine (England). Dept. of Tropical Hygiene. S. Islam, B. S. Drasar, and D. J. Bradley. Journal of Tropical Medicine and Hygiene JTMHA9, Vol. 92, No. 6, p 396-401, December 1989. 3 fig, 2 tab, 23 ref.

Descriptors: *Human pathogens, *Vibrio, *Aquatic bacteria, Aquatic plants, *Algae, *Public health, Bangladesh, Cyanophyta, Chlorophyta, Survival, Salinity.

In Bangladesh, cholera epidemics occur twice a year. *Vibrio cholerae* 01 are readily isolated from the environment only during epidemics. The inter-epidemic reservoirs or sites of survival and multiplication of *V. cholerae* are still unknown. Investigations were carried out with various fresh-water plants as possible reservoirs of *V. cholerae* in the environment. Attachment to and acute population changes of *V. cholerae* on various plant surfaces was used as a screening technique to screen a particular plant species for survival studies. Five plant species, *Anabaena variabilis*, *Rhizoclonium fontanum*, *Cladophora* sp., *Fontinalis antipyretica* and *Elodea canadensis* were used for attachment experiments. Among these plants, *R. fontanum* showed the best attachment. On the basis of attachment results, survival experiments were carried out with *R. fontanum*. At 0.05 ppt salinity, toxigenic *V. cholerae* 01 survive longer in the presence of *R. fontanum* than in medium without algae. (Author's abstract)
W90-05450

NUMERICAL EXPERIMENTS WITH A MATHEMATICAL MODEL OF PHOSPHORUS CYCLING IN THE EPIPLANKTON OF LAKE GLEBOKIE.

Polish Academy of Sciences, Warsaw. Zaklad Paleobiologii. J. Uchmanski. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 147-156, November 1989. 5 fig, 4 tab, 1 ref.

Descriptors: *Path of pollutants, *Limnology, *Lakes, *Eutrophic lakes, *Phosphorus, *Cycling nutrients, *Zooplankton, *Phytoplankton, *Aquatic bacteria, *Detritus, *Water temperature, *Transparency, *Fish farming, Mathematical models, Seasonal variation, Lake Glebokie, Poland.

Lake Glebokie in northeast Poland is a deep, eutrophic lake with large internal loading, additionally loaded by artificial fish farming. The model describes seasonal changes in 6 variables: predatory and non-predatory zooplankton, phytoplankton, bacteria, detritus, and phosphorus. The results of a stability analysis show that in phase space the model is characterized by a single stable point with converging oscillations of all variables about it. Several numerical experiments were performed. The results of changing the level and time distribution of the internal loading, which can simulate real efforts at changing the oxygen conditions near the bottom, were investigated. The influence of stopping the fish farming in the lake, cooling or heating the lake water, and changing light transparency were also studied. These experiments have shown that the internal phosphorus loading of the lake is the major force of the lake dynamics. (Author's abstract)
W90-05466

SIMULATION OF RESERVOIRS IN A GLOBAL DESCRIPTION OF MOVEMENT OF POLLUTION IN THE ENVIRONMENT.

Research Inst. of Fuel and Energy Complex,

Prague (Czechoslovakia).

I. Chytil. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 219-222, November 1989.

Descriptors: *Model studies, *Path of pollutants, *Reservoirs, *Rivers, Thermal stratification, Flow, Dams, Simulation.

In modeling the movement of pollutants on river networks, one has to consider tens, perhaps hundreds, of reservoirs. It is necessary to divide these reservoirs into several basic groups and to construct a simple model for each group. In through-flow reservoirs, the total volume of the reservoir divided by the flow is less than approximately 15 days and the length is 10 or more times greater than the width. This type of reservoir can be simulated as a free-flowing river. Dam reservoirs with temperature stratification have a large ratio of reservoir volume to flow rate which is greater than approximately 15 days, the main outflow being beneath the water surface at a depth frequently more than 10 m. In most cases the length is 10 times longer than the width. The density (temperature) stratification significantly influences movement of water in the reservoir because water moves in different layers dependent on temperature. The basic difference between deep lakes and dam reservoirs with temperature stratification is that the outflow is at the level of the water surface. These two groups differ in terms of water movement and also in lag time during the year. Shallow reservoirs are characterized by a large surface and small depth. Movement of water in these reservoirs is strongly influenced by the shape of the bottom and by the wind. Pumped storage systems of reservoirs are in most cases represented by two reservoirs with temperature stratification. Their characteristic feature is that the pumped volume of water is significantly larger than the volume of water flowing in one day in system reservoirs, so the dominant water movement in these reservoirs is the repumping of water between reservoirs. Non through-flow reservoirs have a special character in terms of water use. Water is allowed into the empty reservoir. The water stays in the reservoir without outflow. Inflow replaces only evaporation of water, and after a time period the reservoir is discharged. In most cases predictive models can be used for calculation of pollutants in these six types of reservoirs. The exact solution for reservoirs requires a separate solution for each reservoir. (Sand-PTT)
W90-05473

INITIAL TEST OF THE BENCHMARK CHEMICAL APPROACH FOR PREDICTING MICROBIAL TRANSFORMATION RATES IN AQUATIC ENVIRONMENTS.

Technology Applications, Inc., Athens, GA. T. D. Newton, D. K. Gattie, and D. L. Lewis. Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 288-291, January 1990. 4 tab, 5 ref.

Descriptors: *Fate of pollutants, *Biotransformation, *Biodegradation, Sediments, Biofilms, Microbial mats, Streams, Lakes, Wetlands, Chlorinated organic compounds, Parathion, Georgia, Florida, Rate coefficient.

Using 2,4-dichlorophenoxyacetic acid methyl ester (2,4-DME) as a benchmark chemical, relative pseudo-first-order rate coefficients were determined for the butoxyethyl ester of 2,4-dichlorophenoxyacetic acid (2,4-DBE), methyl parathion, and methyl-3-chlorobenzoate in a diversity of microbial samples, including water, sediment, biofilm, and floating microbial mats collected from a laboratory mesocosm as well as from streams, lakes, and wetlands in Georgia and Florida. The decreasing order of reactivity for relative microbial transformation rates was 2,4-DBE > 2,4-DME > methyl-3-chlorobenzoate > methyl parathion. Half-lives of the chemicals varied from about 60-fold depending on the chemical and microbial sample. Relative rate coefficients, however, typically varied only about threefold for field-collected samples. Relative rate coefficients determined with samples from a laboratory mesocosm were consistently low compared with the field sample

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data. Overall, the data indicated that microbial transformation rates of a chemical can be satisfactorily inferred for a wide variety of microbial habitats—such as water, biofilm, or a sediment—on the basis of its transformation rate relative to that of an appropriate benchmark chemical by using a single type of microbial sample. (Author's abstract)
W90-05488

ORGANOMERCURIAL-VOLATILIZING BACTERIA IN THE MERCURY-POLLUTED SEDIMENT OF MINAMATA BAY, JAPAN.

National Inst. for Minamata Disease, Minamata (Japan). Dept. of Basic Medical Science. K. Nakamura, M. Sakamoto, H. Uchiyama, and O. Yagi.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 1, p 304-305, January 1990. 1 tab, 17 ref.

Descriptors: *Marine bacteria, *Bacterial physiology, *Japan, *Water pollution, *Mercury, *Biotransformation, *Fate of pollutants, Sediments, Minamata Bay, Path of pollutants, Sediment contamination, Organomercury compounds.

A total of 4,604 bacterial strains isolated from the sediments of Minamata Bay and nearby low-level mercury stations (control stations) were screened for the ability to volatilize mercury from inorganic and organic mercurial compounds. The strains that volatilize from several kinds of organomercurials were found only in the sediments of Minamata bay. All of these strains belonged to the genus *Bacillus*. Organomercurial-volatilizing bacteria having organomercurial lyase with a special wide-range substrate specificity may have been selected by the pressure of mercury in the mercury-polluted sediments. (Author's abstract)
W90-05489

GROUND-WATER CONTAMINATION AT AN INACTIVE COAL AND OIL GASIFICATION PLANT SITE, GAS WORKS PARK, SEATTLE, WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div. G. L. Turney, and D. F. Goerlitz.

Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4224, 1989. 31p, 7 fig, 6 tab, 25 ref.

Descriptors: *Groundwater pollution, *Coal gasification, *Gasification, *Water pollution sources, *Washington, *Cyanide, *Aromatic compounds, *Hydrocarbons, *Organic compounds, Specific conductivity, Trace metals, Seattle, Soil contamination, Volatile organic compounds.

Gas Works Park, in Seattle, Washington, is located on the site of a coal and oil gasification plant that ceased operation in 1956. During operation, many types of wastes, including coal, tar, and oil, accumulated on site. The park soil is presently (1986) contaminated with compounds such as polynuclear aromatic hydrocarbons, volatile organic compounds, trace metals, and cyanide. Analyses of water samples from a network of observation wells in the park indicate that these compounds are also present in the groundwater. Polynuclear aromatic hydrocarbons and volatile organic compounds were identified in groundwater samples in concentrations as large as 200 mg/L. Concentrations of organic compounds were largest where groundwater was in contact with a nonaqueous phase liquid in the soil. Concentrations in groundwater were much smaller where no nonaqueous phase liquid was present, even if the groundwater was in contact with contaminated soils. This condition is attributed to weathering processes at the site, such as dissolution, volatilization, and biodegradation. Soluble, volatile, low-molecular-weight organic compounds are preferentially dissolved from the nonaqueous phase liquid into the groundwater. Where no nonaqueous phase liquid is present, only stained soils containing relatively insoluble, high-molecular-weight compounds remain; therefore, contaminant concentrations in the groundwater are much smaller. Concentrations of organic contam-

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nants in the soils may still remain large. Values of specific conductance were as large as 5,280 microsiemens/cm, well above a background of 242 microsiemens/cm, suggesting large concentrations of minerals in the groundwater. Trace metal concentrations, however, were generally < 0.010 mg/L, and below limits of US EPA drinking water standards. Cyanide was present in groundwater samples from throughout the park, ranging in concentration from 0.01 to 8.6 mg/L. (Author's abstract) W90-05550

COMPOSITION, DISTRIBUTION, AND HYDROLOGIC EFFECTS OF CONTAMINATED SEDIMENTS RESULTING FROM THE DISCHARGE OF GOLD MILLING WASTES TO WHITEWOOD CREEK AT LEAD AND DEADWOOD, SOUTH DAKOTA.

Geological Survey, Rapid City, SD. Water Resources Div. K. E. Goddard.

Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4051, 1989. 76p, 20 fig, 14 ref, 31 ref.

Descriptors: *Water pollution sources, *Sediment contamination, *Gold mining, *Sediment transport, *South Dakota, *Mine wastes, Arsenic, Whitehead Creek, Belle Fourche River, Flood plains.

Between 1876 and 1977, as much as 100 million tons of mining and milling wastes derived from gold mining activities were discharged into Whitehead Creek and its tributaries at Lead and Deadwood, South Dakota. An unknown, but substantial proportion of these wastes were deposited on the flood plains along Whitehead Creek and the Belle Fourche River either as thick deposits adjacent to meanders or as extensive, thinner overbank deposits. The wastes mostly are fine-grained mill tailings that originally contained 7-8% iron-sulfide minerals, including the mineral arsenopyrite (FeAsS), as well as metallic mercury and cyanide compounds added during the milling process. Comparisons between natural, uncontaminated sediment samples and contaminated sediment samples indicate that arsenic is the most anomalous trace constituent; uncontaminated sediment samples had a mean As concentration of 9.2 micrograms/gm, whereas contaminated sediment samples had a mean As concentration of 1,920 microg/gm. Results of a stratified, random, sediment sampling program indicate that most of the near surface sediments on the flood plains along Whitehead Creek and the Belle Fourche River are contaminated by As. On the flood plain along Whitehead Creek downstream from the junction with Gold Run, 82% of the near surface sediment samples contained anomalously large concentrations of As; the mean As concentration was 1,400 microg/gm with a maximum concentration of 11,000 microg/gm. Although the As concentrations were anomalously large in 71% of the sediment samples collected from the Belle Fourche River flood plain, the mean As concentrations gradually decreased downstream from about 1,300 microg/gm just downstream from the junction with Whitehead Creek to about 400 microg/gm near the mouth. Appreciable surface water contamination caused by the contaminated sediments is confined to Whitehead Creek and a reach of the Belle Fourche River downstream from the junction with Whitehead Creek. Groundwater contamination in the alluvial aquifers along Whitehead Creek and the Belle Fourche River is limited to areas in direct contact with large deposits of contaminated sediments. The dissolved As concentration was larger than the standard of 50 microg/L in water from 4 of 36 sampled wells and had a maximum concentration of 280 microg/L. (Lantz-PTT) W90-05553

ESTIMATION OF HYDROCARBON BIODEGRADATION VELOCITIES IN TIDAL SEDIMENTS UNDER STANDARD CONDITIONS.

Oldenburg Univ. (Germany, F.R.). Fachbereich 7 - Biologie. U. Kant, K. Kiesewetter, M. Michaelson, and T.

Hoepner.

Available from the National Technical Information Service, Springfield, VA 22161, as TIB/A88-83008. Price code: E07 in paper copy. Final Report, 1985. 48p, 18 fig, 2 tab, 40 ref.

Descriptors: *Hydrocarbons, *Biodegradation, *Fate of pollutants, *Oil, *Tidal flats, *Marine sediments, Path of pollutants, Hexadecane, Bacteria, Aerobic environment, Biological studies.

Hexadecane and raw oil biodegradation rates in aerobic sediments from intertidal mudflats were determined in laboratory experiments and under observation of the development of the bacterial numbers (total colony forming units). Dependencies on nutrients and dispersants were examined. The main results are: (1) Hydrocarbon biodegradation shows a clear dependence on nutrients even in natural fresh sediments. In the presence of nutrients biodegradation rates are about 1000-fold higher than in sea water, in the absence of nutrients degradation is very slow. Addition of adapted bacteria does not accelerate the degradation. Under field conditions and oxygen limitation the dependence on nutrients is not visible. (2) There is an interdependence between hydrocarbon degradation and development of total colony forming units. Bacterial number attains a maximum after 10-20 days when hydrocarbon degradation overcomes a lag phase. At the maximum, the bacterial number is dependent on the addition of hydrocarbons and nutrients, and independent of the initial bacteria number. (3) The tested dispersants Corexit 9527, Metyl OD and THL do not have a positive or negative effect on hydrocarbon biodegradation rates. There are no reasons to use then in an aerobic sediment. It cannot be excluded that Corexit 9526 and Metyl OD enhance hydrocarbon toxicity against bacteria. This effect can be excluded for THL. (4) It is necessary to include biodegradation into the management of an oil pollution of the sediment surface. The first means to accelerate hydrocarbon biodegradation in sediments is oxygen supply by sediment agitation. Having overcome oxygen limitation by sediment agitation, nutrient limitation has to be examined and overcome. (Lantz-PTT) W90-05561

PETROLEUM FATE AND CLEANUP AGENT TOXICOLOGY: AN ANNOTATED BIBLIOGRAPHY.

California Univ., Santa Cruz. Center for Marine Studies.

R. S. Tjeerdema, G. E. Croston, L. M. Swall, and M. Martin.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134580. Price codes: A06 in paper copy, A01 in microfiche. Report No. UCSC/IMS-88/1, December 1988. 120p.

Descriptors: *Oil pollution, *Fate of pollutants, *Bibliographies, *Toxicology, *Oil spills, *Cleanup operations, Water pollution, Wildlife, Marine environment.

California State Senate Bill 686 allocated funds for examination of the toxic effects of oil spill cleanup agents on indigenous wildlife and marine species. This annotated bibliography, representing one objective of the bill, presents available literature on the environmental fate of petroleum and on all aspects of cleanup agent toxicology. Along with listing abstracts, when available, it also contains an extensive index to facilitate searches in specific subject areas. (Author's abstract) W90-05583

SUPERFUND RECORD OF DECISION: OLD BETHPAGE, NY.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W90-05584

DEGRADATION OF POLYCYCLIC AROMATIC HYDROCARBON COMPOUNDS UNDER VARIOUS REDOX CONDITIONS IN SOIL-WATER SYSTEMS.

Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.

J. R. Mihelcic, and R. G. Luthy.

Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016843. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/FC/10619-2518, October 1987. 23p, 10 fig, 27 ref. DOE Contract DE-AC18-84FC10619.

Descriptors: *Biodegradation, *Fate of pollutants, *Aromatic compounds, *Hydrocarbons, *Soil water, Microbial degradation, Naphthol, Naphthalene, Acenaphthene, Chemical degradation, Aerobic conditions, Anaerobic conditions, Denitrification.

The microbial degradation of naphthol, naphthalene, and acenaphthene under aerobic, strict anaerobic, and denitrification conditions in soil water systems was evaluated. Chemical degradation of naphthol and naphthalene in the presence of a manganese oxide was also studied. Naphthol, naphthalene, and acenaphthene were degraded microbially under aerobic conditions from initial aqueous phase concentrations of 9, 7, and 1 mg/L to nondetectable levels in 3, 10, and 10 days respectively. Under anaerobic conditions naphthol degraded to nondetectable levels in 15 days while naphthalene and acenaphthene showed no significant degradation over time periods of 50 and 70 days respectively. Under denitrification conditions naphthol, naphthalene, and acenaphthene were degraded from initial aqueous phase concentrations at 8, 7, and 0.4 mg/L to nondetectable levels in 16, 45, and 40 days respectively. Acclimation periods of approximately 2 days under aerobic conditions, and 2 weeks under denitrification conditions, were observed for both naphthalene and acenaphthene. Abiotic degradation of naphthalene and naphthol was evaluated by reaction with manganese oxide, a minor soil constituent. In the presence of a manganese oxide naphthalene showed no abiotic degradation over a time period of nine weeks, while aqueous naphthol concentration decreased from 9 mg/L to nondetectable levels in 9 days. The results of this study show that low molecular weight, unsubstituted polycyclic aromatic hydrocarbons are amenable to microbial degradation in soil-water systems under denitrification conditions. This type of compound may otherwise persist in soil-water systems in the absence of nitrate and molecular oxygen, or a suitable substituent group on the aromatic ring. (Author's abstract) W90-05586

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS 1984-87.

Geological Survey, Tucson, AZ. Water Resources Div.

J. H. Eychaner, M. R. Rehmann, and J. G. Brown. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-410, October 1989. 105p, 2 fig, 19 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Arizona, *Monitoring, *Hydrologic data collections, *Acid mine drainage, Pinal Creek Basin, Sediment density, Chemical analysis, Mineralogy, Particle size.

Occurrence and movement of acidic contamination in the aquifer and streams of the Pinal Creek basin near Globe, Arizona, is the focus of an ongoing study by the US Geological Survey. Groundwater data from that study for water years 1984 to 1987 include location, construction information, and site plans for six groups of monitoring wells, mineralogic and particle-size analyses of drill cuttings, water-level measurements, and chemical analyses of water samples from 39 wells. Surface water data for 13 sites in this study include discharge measurements and chemical analyses of water and streambed sediment samples. Monthly discharge data are presented for one site. Monthly precipitation amounts and statistics of long-term precipitation are presented for two sites. (Author's abstract)

Effects Of Pollution—Group 5C

W90-05600

WATER RESOURCES OF SEDGWICK COUNTY, KANSAS.

Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05605

5C. Effects Of Pollution

DEVELOPMENT OF WATER RELEASE PLANS FOR MINIMIZING FISH KILLS BELOW TULSA DISTRICT, CORPS OF ENGINEERS IMPROVEMENTS.

Corps of Engineers, Tulsa, OK. Tulsa District.
For primary bibliographic entry see Field 8I.
W90-04607

EXPERIMENTAL STUDIES ON THE EFFECTS OF ZINC ON ERPOBDELLA OCTULATA (L.) (ANNELIDA: HIRUDINEA) FROM THE AFON CRAFTNANT, N. WALES.

Cauldon College of Further and Higher Education, Stoke Road, Shelton, Stoke on Trent, ST4 2DG, England.
M. Willis.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 4, p 449-469, 1989. 3 fig, 8 tab, 26 ref.

Descriptors: *Water pollution effects, *Zinc, *Mine wastes, *Toxicity, *Annelids, *Leeches, *Bioaccumulation, Artificial stream tanks, Larval growth stage, Reproduction, Animal behavior, Afon Craftnant, Wales.

Experiments were conducted to clarify the results of a field survey of the leech, *Erpobdella octulata*, population in the Afon Craftnant, N. Wales, a stream polluted by zinc from mine waste. The effects of a range of Zn concentrations on the survival, growth, reproduction success and behavior of the leech were studied by use of toxicity tests, breeding populations in artificial stream tanks, static water experiments and a counter-current tank. The blotted wet weight of the leeches was used to estimate growth, reproductive success was measured by estimating the number of cocoons and the number of eggs per cocoon, behavioral responses by avoidance-preference experiments, and bioaccumulation of zinc by wet ashing and flame atomic absorption spectrophotometry. In the short-term, one-year-old leeches were more tolerant of zinc than newly-hatched *Erpobdella* which after 50 days' exposure from hatching were affected lethally. There was an observed tendency for the reproductive capacity of *Erpobdella* to be adversely affected at 320 and 180 microgram Zn/l with the production of more flat, misshapen cocoons devoid of eggs, a delay in deposition of cocoons and prolonged development of eggs in cocoons. Avoidance of zinc by adult leeches was observed. Active uptake of zinc by *Erpobdella* at low concentrations of zinc in solution was confirmed. Zinc pollution is a probable cause of a reduction of density and reduced reproductive capacity of *Erpobdella* in the Afon Craftnant. (Sand-PTT)

W90-04630

DOSE-RESPONSE RELATION BETWEEN ARSENIC CONCENTRATION IN WELL WATER AND MORTALITY FROM CANCERS AND VASCULAR DISEASE.

Academia Sinica, Taipei (Taiwan). Inst. of Biomedical Sciences.
M. M. Wu, T. L. Kuo, Y. H. Hwang, and C. J. Chen.
American Journal of Epidemiology AJEPAS, Vol. 130, No. 6, p 1123-1132, December 1989. 1 fig, 4 tab, 53 ref.

Descriptors: *Arsenic, *Water pollution effects, *Well water, *Drinking water, *Toxicity, *Carcinogens, *Human diseases, *Epidemiology, Cancer, Vascular diseases, Taiwan, Public health.

Age-adjusted mortality rates were analyzed to examine the dose-response relation between ingested

arsenic levels and risk of cancers and vascular diseases among residents in the endemic area of blackfoot disease, a unique peripheral vascular disease associated with long-term exposure to high-arsenic artesian well water and confined to the southwestern coast of Taiwan. The arsenic levels in well water determined in 1964-66 were available in 42 villages of the study area, while mortality and population data during 1973-86 were obtained from local household registration offices and Taiwan Provincial Department of Health. Age-adjusted mortality rates from various cancers and vascular diseases by sex were calculated using the 1976 world population as the standard population. A significant dose-response relation was observed between arsenic levels in well water and cancers of the bladder, kidney, skin, and lung in both males and females, and cancers of the prostate and liver in males. However, there was no association for cancers of the nasopharynx, esophagus, stomach, colon, and uterine cervix, and for leukemia. Arsenic levels of well water were also associated with peripheral vascular diseases and cardiovascular diseases in a dose-response pattern, but not with cerebrovascular accidents. The dual effect of arsenic on carcinogenesis and arteriosclerosis and the interrelation between these two pathogenic mechanisms deserve more intensive study. (Author's abstract)

W90-04634

BACTERIOLOGICAL ASPECTS OF FLORIDA RED TIDES: A REVISIT AND NEWER OBSERVATIONS.

Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 2L.
W90-04643

LONG-TERM COMPARISON OF ZOOPLANKTON COMMUNITIES BETWEEN THERMALLY-ALTERED AND AMBIENT AREAS OF A NORTH CAROLINA COOLING RESERVOIR.

Wake Forest Univ., Winston-Salem, N.C. Dept. of Biology.
D. J. Marcogliese, G. W. Esch, and R. V. Dimock.
Journal of the Elisha Mitchell Scientific Society JEMSA5, Vol. 105, No. 1, p 1-13, Spring 1989. 7 fig, 2 tab, 26 ref.

Descriptors: *Zooplankton, *Cooling ponds, *Thermal pollution, *Reservoirs, *Selenium, *Water pollution effects, Fish predation, Species composition, Population density, Belevs Lake, North Carolina, Selenium.

Zooplankton community diversity from a thermally-altered effluent arm of Belevs Lake, N.C., was similar to that of the ambient area of the cooling reservoir in both 1974-75 and 1984-86. Elevated temperatures did not appear to affect species composition or relative abundance within the community. Changes in zooplankton species diversity that occurred between 1974-75 and 1984-86 in the effluent arm resemble changes in the ambient area. These changes can be attributed to increased size-selective predation by the expanding populations of planktivorous fish subsequent to elimination of piscivores during 1976-77 as a result of selenium pollution in the reservoir. (Author's abstract)

W90-04647

SEDIMENT TOXICITY ASSESSMENT USING BACTERIAL BIOLUMINESCENCE: EFFECT OF AN UNUSUAL PHYTOPLANKTON BLOOM.

Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
For primary bibliographic entry see Field 7B.
W90-04655

EFFECTS OF SIMULATED ACID RAIN ON GROWTH PARAMETERS AND YIELD COMPONENTS OF TWO SOYBEAN CULTIVARS. Illinois Univ., Urbana. Dept. of Agronomy.
P. M. Porter, W. L. Banwart, E. L. Ziegler, B. L. Vasilas, and J. J. Hassett.
New Phytologist NEPHAV, Vol. 113, No. 1, p 77-83, September 1989. 3 tab, 23 ref. EPA cooperative agreement No. 810725-01.

Descriptors: *Acid rain effects, *Soybeans, *Crop yield, Simulated rainfall, Plant growth.

The effects of simulated acid rain on two soybean (*Glycine max*) cultivars were studied in field experiments in central Illinois from 1983-1985. The cultivars, Amsoy 71 and Williams 82, were shielded from ambient precipitation and treated twice weekly with applications of 1.05 cm of one of six simulated acid rain treatments which ranged in pH from 5.6 to 3.0. Measurements were taken for plant height, chaff dry weight, plant population, lodging, pods/plant, seeds/plant, seeds/pod, mass/seed, and number of low pods. There were small but significant effects of treatment acidity in some years for some of the parameters measured. For Amsoy 71, in one of three years, seeds/plant, seeds/pod, and chaff dry weight were reduced by increasing acidity of the simulated rain. In general, Amsoy 71 plants subjected to the more acidic treatments were shorter and had lower lodging in the second and third years of the experiments. For Amsoy 71 there were no significant linear contrasts for the effect of simulated acid rain on plants/ha, mass/seed, and protein concentration of the seed. For Williams 82 there was a small but significant trend for increased seed oil with decreasing pH in 1984 only. For this cultivar there were no significant linear contrasts for the effect of simulated acid rain on plants/ha, plant height, lodging score, chaff dry weight, low pods, pods/plant, seeds/plant, seeds/pod, or mass/seed. Where changes in either cultivar occurred, the magnitude of these changes over the entire pH range studied was generally 6% or less. Not only was the magnitude of the responses minimal, but the response to simulated acid rain was not consistent between cultivars or in some cases within cultivars from year to year. The response to simulated acid rain was also small when compared with the potential effect of other stresses such as drought, ozone, disease, insects, and weeds on soybean yield and growth parameters. (Author's abstract)

W90-04656

ALUMINIUM TOXICITY TO RAINBOW TROUT AT LOW PH.

Eidgenossische Technische Hochschule, Zurich (Switzerland). Inst. of Toxicology.
D. Deitrich, and C. Schlatter.

Aquatic Toxicology AQTOGD, Vol. 15, No. 3, p 197-212, October 1989. 4 fig, 4 tab, 45 ref.

Descriptors: *Toxicity, *Aluminum, *Trout, *Hydrogen ion concentration, *Acid rain effects, *Water pollution effects, Gills, Bioaccumulation, Electrolytes.

An acute toxicity study of aluminum (Al) at low pH, using 1-yr-old rainbow trout (*Salmo gairdneri* R.), was performed in a closed recirculating system at pH 5.2, 5.4, and 5.6 with nominal concentrations of 0, 100, 200, and 400 micrograms Al/liter. Mortality (96 hr) was dependent on the pH and Al concentration. Measurements of (Al) in the plasma of exposed fish, by electrothermal atomic absorption spectrometry, showed a dose-dependent uptake of Al, but no correlation of plasma Al concentration to the mortality observed. Three major mechanisms of pH-Al toxicity seemed to prevail: (1) relatively low nominal Al concentrations (100 and 200 micrograms/liter) at pH 5.2 as well as 200 micrograms Al/liter at pH 5.4 led to electrolyte loss possibly due to an interaction of Al with enzymes and epithelial tight junctions in the gill of the exposed fish; (2) exposing fish to Al concentrations of > or = 100 micrograms/liter and pH values > or = 5.2 enhanced cell necrosis, proliferations, and fusions of the secondary lamellae in the gills resulting in the obstruction of the interlamellar space and thus most likely in the impairment of gas exchange. Al fractionation suggested that inorganic monomeric Al was responsible for this tissue damage; (3) high Al concentrations (> or = 200 micrograms/liter) at moderately low pH (> or = 5.4) led to clogging of the gills with mucus and thus to an impairment of gas exchange. This mucification was thought to stem from the physical irritation of the gills by accumulating polymeric Al. (Author's abstract)

W90-04670

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects Of Pollution

MENADIONE-STIMULATED OXYRADICAL FORMATION IN DIGESTIVE GLAND MICROSOMES OF THE COMMON MUSSEL, MYTILUS EDULIS L.

Marine Biological Association of the United Kingdom, Plymouth (England).
D. R. Livingstone, F. G. Martinez, and G. W. Winston.

Aquatic Toxicology AQOTODG, Vol. 15, No. 3, p 213-236, October 1989. 1 fig, 6 tab, 74 ref. NATO Grant RG86/0534. CEC Grant ST2J-0077-1-UK(CD).

Descriptors: *Quinones, *Mussels, *Oxidation-reduction potential, *Water pollution effects, *Oxygen requirements, Toxicity, Mollusks, DNA, Digestion, Enzymes, Biochemistry, Ecological effects.

Electron reduction pathways of the quinone, menadione (2-methyl-1,4-naphthoquinone) were studied in digestive gland extracts from the mussel, *Mytilus edulis* L. Hydroxyl radical production was measured by the oxidative decarboxylation of benzoic acid, using ferric/EDTA as a catalyst of the Haber-Weiss reaction. Menadione stimulated both NADPH/ and NADH/cytochrome c reduction, with the absolute increase in rate being an order of magnitude greater for NADH than NADPH. The increase in NADH/cytochrome c reduction was largely due to one-electron reductive processes whereas that of NADPH was indicated to have significant contributions from both this and menadiol formation. The stimulation of NADPH-dependent cytochrome c reduction plateaued at 500 micromoles menadione, whereas the NADH-dependent reaction was still increasing at 1 micromole menadione. A similar pattern of menadione-stimulation was observed for NAD(P)H-dependent OH production, with OH being formed, at least in part, from O₂(-) and hydrogen peroxide. The specific activity of microsomal DT-diaphorase (NAD(P)H:quinone oxidoreductase) was twice as high with NADPH than NADH as coenzyme. The results are consistent with (1) menadione-mediated redox cycling and generation of O₂(-) from both NADH and NADPH, (2) a greater potential for oxyradical production from NADH than NADPH, and (3) NADPH-dependent oxyradical production being limited by the antioxidant microsomal DT-diaphorase converting menadione to menadiol. Oxyradical generation, redox cycling and elevation of cytochrome P-450 content and NADPH-cytochrome c (P-450) reductase activity represent a possible mechanism for linking pollution exposure to DNA damage in the digestive gland of mollusks. (Author's abstract)
W90-04671

BRANCHIAL ION FLUXES AND TOXICANT EXTRACTION EFFICIENCY IN LAMPREY (PETROMYZON MARINUS) EXPOSED TO METHYLMERCURY.

Washington State Univ., Pullman. Dept. of Zoology.
C. M. Stinson, and J. Mallatt.

Aquatic Toxicology AQOTODG, Vol. 15, No. 3, p 237-252, October 1989. 3 fig, 1 tab, 60 ref. National Institutes of Health Grant IR01 ESO3240-02.

Descriptors: *Lamprey, *Mercury, *Fish physiology, *Methylmercury, *Membranes, *Water pollution effects, Gills, Toxicity, Bioaccumulation, Permeability.

Larval lampreys (*Petromyzon marinus*) were held in tubes to study the effects of methylmercury on flux rates of Na(+) and Cl(-) across the pharynx and the extraction of methylmercury from solution by the pharynx. Methylmercury was presented to lampreys for 2-4 hr at 13°C in an aqueous medium (0.2 micromoles NaCl and KHCO₃) at a concentration of 180 micrograms Hg/liter (about a 40-hr LC50). Compared to control lampreys, animals exposed to methylmercury exhibited a significantly lower influx of Cl(-), a greater efflux of Na(+), and a greater efflux of Cl(-). Influx of Na(+) was not affected by methylmercury. The elevated efflux of Na(+) and Cl(-) from the gills is consistent with established hypotheses that methylmercury increases the permeability of cell membranes to cations and other small molecules. Lampreys

extracted methylmercury from solution with efficiencies of 41-66%, higher percentages than are recorded for other fish. Such exceptional extraction efficiencies may relate to the soft water used in this study. (Author's abstract)
W90-04672

EFFECT OF SEDIMENT ON CADMIUM AND LEAD IN THE STONE LOACH (NOEMACHEILUS BARBATULUS L.).

Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
P. E. T. Douben, and J. H. Koeman.

Aquatic Toxicology AQOTODG, Vol. 15, No. 3, p 253-268, October 1989. 2 fig, 4 tab, 27 ref.

Descriptors: *Path of pollutants, *Fluvial sediments, *Cadmium, *Lead, *Fish physiology, *Bioaccumulation, Toxicity, Substrates, Fate of pollutants, Water pollution effects, Mathematical models, Sand.

Stone loach (*Noemacheilus barbatulus* L.) of different body sizes were kept with different types of material on the bottom of their aquaria. One type of bottom material was sediment taken from the River Ecclesbourne, Derbyshire, a site with high levels of cadmium (Cd) and lead (Pb). Another type was acid-washed sand (a.w.s.). A third group was kept without any bottom-covering material (control). Fish were starved during the experimental procedure and therefore lost some weight, which was independent of treatment. Body size affected both Cd and Pb burden: the exponent for body weight was 0.88 +/- 0.13 for Cd and 0.59 +/- 0.18 for Pb. Fish with sediment had enhanced body burdens of both Cd and Pb on all occasions while those kept with a.w.s. usually had lower metal levels than control fish. In the presence of sediment from the River Ecclesbourne, by applying a one-compartment model, rate constants for loss of both Cd and Pb were high which resulted in a rapid approach of body burden to a steady state. It was suggested that uptake of metal from sediment was more important as a route of entry for Pb than for Cd under the described conditions. (Author's abstract)
W90-04673

BIOACCUMULATION AND HISTOCHEMICAL LOCALIZATION OF CADMIUM IN DREISSENA POLYMORPHA EXPOSED TO CADMIUM CHLORIDE.

Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
H. J. Herwig, F. Brands, E. Kruitwagen, and D. I. Zandee.

Aquatic Toxicology AQOTODG, Vol. 15, No. 3, p 269-286, October 1989. 11 fig, 1 tab, 30 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Mollusks, *Water pollution effects, Path of pollutants, Kidneys, Gills, Atomic absorption spectrophotometry.

Dreissena polymorpha, a freshwater bivalve, was exposed to dissolved cadmium chloride (100 micrograms Cd/liter) for periods of 1, 2, 3 or 4 wk. Cadmium accumulation was followed by atomic absorption spectrophotometry and the localization of Cd was investigated with a sulfide-silver technique (SST). During the exposure period the soft body accumulated Cd in a linear way, while the shells reached a saturation level after 3 wk. In exposed mussels treated with the SST, reaction products were present in nearly all tissues. The cellular localization and the amount of reaction products varied according to the type of tissue and the duration of exposure. After one week, reaction products indicative for the presence of free or loosely bound Cd were present in granular structures and in the cytoplasm of all epithelia that had been in direct contact with the Cd-contaminated water. After longer exposure times, the epithelial cells as well as the underlying connective tissue became completely filled with reaction products. In the digestive tract, reaction products were confined mainly to granular structures in the epithelial cells. They became prominent after 3 or 4 weeks of exposure. Among the internal organs, the excretory system showed a reaction pattern largely com-

parable to that of the epithelia which had been in direct contact with the Cd-contaminated water. Apart from the pericardial gland, which represents the site of ultrafiltration, the appearance of reaction products in the cytoplasm of the kidney cells was retarded. In the epithelial lining of the gonads and in neural tissue, diffusely distributed reaction products were observed only after longer exposure times. Gametes and muscular tissue, except for the ventricular muscle, remained free of reaction products. Structural damage related to the Cd-exposure was restricted to the pericardial gland. (Author's abstract)
W90-04674

ACUTE TOXICITY OF TEMEPHOS, FENOXYCARB, DIFLUBENZURON, AND METHOPRENE AND BACILLUS THURINGIENSIS VAR. ISRAELENIS TO THE MUMMICHOG (FUNDULUS HETEROCLOTUS).

South Carolina Univ., Columbia. Dept. of Environmental Health Sciences.
B. M. Lee, and G. I. Scott.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 827-832, December 1989. 1 tab, 12 ref.

Descriptors: *Pesticides, *Bioassay, *Toxicity, *Organophosphorus pesticides, *Carbamate pesticides, *Fish, *Insecticides, *Water pollution effects, Ecological effects, Bacillus, Larvicides, Estuaries, Environmental effects, Mosquitoes, Killfish.

The acute toxicity of four chemical mosquito larvicides (methoprene, diflubenzuron, temephos, and fenoxycarb) and *Bacillus thuringiensis* (Bti, in the form of vectobac) to the mummichog (*Fundulus heteroclitus*) was investigated and compared to study the safety of these compounds for mosquito control in estuarine tidal creeks. All acute 96-hr toxicity tests were performed as static renewal bioassays in which the test organisms were exposed to a fresh solution of each larvicide at a range of concentrations every 24 hr. The 96-hr LC50 values were: temephos, 0.04 milligrams/liter; fenoxycarb, 2.32 milligrams/liter; diflubenzuron, 32.99 milligrams/liter; methoprene, 124.95 milligrams/liter; and vectobac 980 milligrams/liter. A 1:1 mixture of fenoxycarb/vectobac was also tested to compare potential additive toxicity. The 96-hr LC50 value of the mixture was 3.1 milligrams/liter which was more toxic to *Fundulus* than fenoxycarb alone. The toxicity of the fenoxycarb/vectobac mixture increased by a factor of 1.49 (magnification factor = 1.49) over the expected simple additive toxicity (magnification factor = 1). Relative safety factors of such larvicides should be considered when selecting appropriate mosquito control treatments in different habitats. (Geiger-PTT)
W90-04675

CLAM BURROWING BIOASSAY FOR ESTUARINE SEDIMENT.

District of Columbia Univ., Washington. Dept. of Biology.
H. L. Phelps.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 838-845, December 1989. 4 fig, 3 tab, 10 ref.

Descriptors: *Bioassay, *Bioindicators, *Marine sediments, *Water pollution effects, *Clams, Animal behavior, Ecological effects, Pollutant identification, Copper, Estuaries.

The suitability of the young of *Mya arenaria*, a commercial soft-shell East coast clam as a bioassay organism for marine sediment pollution was examined in laboratory holding trays containing seawater and copper-spiked marine sediment. Clam burrowing behavior was examined under variables of temperature, clam density, size, fatigue levels, and time held out of sediment. Young *M. arenaria* clams appeared suitable for a rapid burrowing bioassay for estuarine sediment by having an average control burrowing speed (measured by elapsed time for 50% of the clams to burrow, ET50) of 0.45 hr. Up to six bioassays, including a control, can be conducted simultaneously. The clam bur-

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rowing bioassay can be conducted in a small space (pint freezer box size) with about one liter of sediment, at any time of day, and at water temperature from 13 to 27 °C. The bioassay should be conducted with clams approximately the same size. The bioassay was responsive to sediment-sorbed copper. The control population burrowing speeds (ET50) had low variability, and the clams showed good growth and survival when held in a flowing seawater system for seven months. Young clams adapted readily to different salinities and could be stored in sediment at 10 °C if warmed for 24 hr before using in a bioassay. *M. arenaria* appears to be a promising species for a rapid sediment bioassay suitable for the estuaries of the East Coast, that receive intensive sediment pollutant loading. (Geiger-PTT)
W90-04677

CADMIUM AND LEAD ACCUMULATION BY GOLDFISH EXPOSED TO AQUEOUS REFUSE INCINERATOR FLY ASH LEACHATE.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Toxic Chemicals Lab.
For primary bibliographic entry see Field 5B.
W90-04678

EFFECTS OF CHROMIUM AND CADMIUM UPON RESPIRATION AND SURVIVAL OF CALLINECTES SIMILIS.
Universidad Autonoma Metropolitana, Mexico City. Lab. de Contaminacion, Bioensayos e Impacto Ambiental.
P. Ramirez, G. Barrera, and C. Rosas.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 850-857, December 1989. 2 fig, 4 tab, 18 ref.

Descriptors: *Chromium, *Cadmium, *Respiration, *Crabs, *Toxicity, *Water pollution effects, Oxygen uptake, Crustaceans, Bioassay.

Crabs (*Callinectes similis*) obtained from Tamiahua lagoon were exposed to cadmium and chromium in 2-liter polyethylene chambers to determine the LC50 values and the effects of the heavy metals on respiration. Test solutions containing lagoon water and the metals were partially replaced every 24 hr with fresh solution, and oxygen consumption was using the test chambers as closed respirometers. On completion of the tests, surviving animals were sacrificed and dried and the rate of oxygen extraction was calculated and used as an index of alteration in the organism mechanism for capturing and fixing oxygen. The LC50 for Cd was 6.35 milligrams/liter, a level 92% lower than the value for Cr(6+) which was 73.69 milligrams/liter. In the control group, a significant increase of oxygen consumption was observed between the 6 and 12 hr of exposition followed by a decrease and finally by its stabilization. In contrast, this increase of respiratory rate was only observed on experimental crabs exposed to Cd within the 6 hr interval, except for the 6.40 milligrams/liter concentration. In terms of metabolic levels, no significant differences were observed between those crabs exposed to Cd and the control, except for the 3.96 milligrams/liter concentration. The percentage of oxygen extraction registered higher levels for the control case during the first 12 hr, as compared to the test cases. The test crabs exposed to Cr(6+) had considerably lower metabolic rates when compared to the control, registering a downward tendency in this area throughout the test period. On the other hand, the control was observed to reach its oxygen consumption maximum levels during the first part of the test period, as well as toward the end of the period. The behavior of oxygen extraction percentage, however, showed more similar patterns to those observed for the crabs exposed to Cd: a significant increase in this variable was observed during the first hours of the test, followed by the stabilization of these levels thereafter. (Geiger-PTT)
W90-04679

EFFECTS OF LEAD ON THE SPAWNING POTENTIAL OF THE FRESH WATER FISH, ANABAS TESTUDINEUS.
Osmania Univ., Hyderabad (India). Dept. of Zool-

ogy.

S. J. Tulasi, P. U. M. Reddy, and J. V. R. Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 858-863, December 1989. 3 tab, 10 ref.

Descriptors: *Spawning, *Lead, *Fish physiology, *Bioassay, *Water pollution effects, Heavy metals, Fish eggs, Toxicity, Bioaccumulation.

Fresh water fish, *Anabas testudineus* were exposed in laboratory tanks to different concentrations of lead nitrate and LC50 values were determined by the Probit method. The LC50 value for 96 hr was 60 ppm. Mature females of uniform size and length were exposed to sublethal concentrations of lead nitrate (1.25, 2.5, 5.0 and 20.0 milligrams/liter) for a period of 30 days. The water in the tanks was renewed every day and at the end of the experimental period, six fish from each group were sacrificed. The size frequency analysis of oocytes in the ovary was used as an indicator of spawning period, and ovary weight and length were noted. Lead concentration in the ovary and brain was determined by atomic absorption spectrophotometry. Upon exposure to lead, the number of eggs in the ovary were reduced. The ovary was small and regressed in a dose dependent manner; and the gonosomatic index was significantly reduced in exposed fish. Lead uptake in the ovary tissue of the exposed fish was greatly reduced compared to brain tissue and was found to increase with lead concentration. The spawning values reached approximately 62% during the 30 days of spawning in control fish, where as in lead exposed fish spawning was 83%, 95%, 97%, and 99% at the end of the 30 day exposure period. The number of ova/gm of body weight, ova/cm of body length, ova/gm of ovary were all reduced on exposure to lead. (Geiger-PTT)
W90-04680

TOXICOLOGICAL ASPECTS OF ACTIVATED SLUDGE FEEDING.

Agricultural Research Organization, Bet-Dagan (Israel). Dept. of Animal Nutrition.
E. Nachtom, B. Lipstein, and S. Kary.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 6, p 879-885, December 1989. 3 tab, 16 ref.

Descriptors: *Activated sludge, *Sludge utilization, *Sludge disposal, *Birds, *Toxicity, *Heavy metals, Enzymes, Ecological effects, Iron, Zinc, Organic compounds, Physiology, Feeds.

The effects of diets containing activated sludge or activated sludge minerals (iron and zinc) on the enzyme activities responsible for the detoxification mechanisms in Leghorn chicks were studied. A 48-hr period of fasting increased the sensitivity of chicks to the sludge diet. Two hours after feeding glutathione concentration in the liver and kidneys decreased in sludge-fed chicks, but rose significantly after 4 hr. At 24 hr after sludge feeding, a significant rise in microsomal cytochrome P-450 concentration occurred. Feeding diets containing sludge levels of iron and zinc to leghorn chicks increased the level of iron in the liver, but not the amount of zinc in the experimental groups. However, addition of ferrous sulfate and zinc carbonate to the diet, in amounts equivalent to the metals found in the sludge, did not affect the enzymes examined in the livers, except for the slight enhancement of the activity of glutathione in liver cytosol. The present results point to the possible presence of organic toxins in the sludge that could induce the hepatic cytochrome P-450 required in their oxidative detoxification, leading to oxidative stress and H2O2 formation. (Geiger-PTT)
W90-04683

ENVIRONMENTAL DYNAMICS OF THE CARBAMATE INSECTICIDE ALDICARB IN SOIL AND WATER.

Dunn Geoscience Corp., Albany, NY.
For primary bibliographic entry see Field 5B.
W90-04686

USE OF MIXED-FUNCTION OXYGENASES TO MONITOR CONTAMINANT EXPOSURE IN WILDLIFE.

Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5A.
W90-04689

BIOCHEMICAL RESPONSES IN AQUATIC ANIMALS: A REVIEW OF DETERMINANTS OF OXIDATIVE STRESS.

Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
G. W. Winston, and C. S. Jewell.
Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1103-1123, 1989. 5 fig, 3 tab, 170 ref.

Descriptors: *Toxicology, *Water pollution effects, *Aquatic animals, *Bioindicators, *Toxicity, *Oxidation, Stress, Monitoring, Aerobic conditions, Oxidation-reduction potential, Invertebrates, Parquat, Fish, Carcinogenesis, Water pollution effects.

The study of biochemical responses in aquatic animals comprises a vigorous area of inquiry within ecotoxicology because of the need for basic research in the field, the desire for highly sensitive biomarkers useful for biomonitoring and the particular concern for elevated rates of neoplasia observed in some aquatic systems. An approach is described based on the ability of diverse contaminants to undergo metabolism through free radical intermediates and thereby produce toxic effects associated with oxidative stress. Of particular concern to environmental toxicologists with respect to these phenomena are the abilities of a number of common and diverse compounds to undergo enzymatically facilitated redox cycling in cells and thereby generate oxyradicals. Xenobiotics such as quinones, aromatic nitro compounds, aromatic hydroxylamines, bipyrindyls and certain metal chelates may represent particularly prolific sources of oxygen radicals. These radicals through redox cycling may produce quantities of O₂, H₂O₂ and OH(·) that overcome the protection afforded by antioxidant defense mechanisms leading to oxidative damage in tissue macromolecules including DNA, proteins, and lipids. Endogenous antioxidant defense systems include water soluble reductants, fat soluble vitamins, and enzymes. Methodologies for detecting these radicals in vivo and in vitro are discussed and recent studies demonstrating their applicability to aquatic toxicology are reviewed. In vitro studies have included nitroaromatic-stimulated superoxide production in fish fractions, parquat-stimulated superoxide production in bivalve microsomes, and hydroxyl radical production during invertebrate microsomal electron transport. In addition in vivo, as well as in vitro lipid peroxidation has been investigated in a number of species. (Geiger-PTT)
W90-04690

BIOCHEMICAL ANALYSIS OF ALLOZYME COPPER AND CADMIUM TOLERANCE IN FISH USING STARCH GEL ELECTROPHORESIS.

Miami Univ., Oxford, OH. Dept. of Zoology.
N. L. Chagnon, and S. I. Guttman.
Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1141-1147, 1989. 3 fig, 2 tab, 36 ref.

Descriptors: *Copper, *Cadmium, *Fish physiology, *Toxicology, *Biochemistry, *Heavy metals, *Water pollution effects, *Enzymes, *Electrophoresis, Separation techniques, Suckers, Fathead minnows, Chubs, Perch, Shiner, Suckers.

The in vitro effects of copper and cadmium on fish enzyme activity were assayed by combining the metals with the biochemical stains used to resolve these enzyme systems on starch gels. The effects of copper and cadmium on the activity of phosphoglucomutase-2 (PGM-2), glucose-6-phosphate isomerase-2 (GPI-2) and isocitrate dehydrogenase-2 (IDH-2) enzymes in mosquitofish were assayed using stain-metal mixtures containing 2.0 ml 0.1 M CuSO₄·5H₂O or 0.1 M CdSO₄. Enzymes whose

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activities were effected by copper in this initial test were resolved using a series of stain-metal mixtures containing copper at lower concentrations to determine effect threshold concentration ranges and to determine concentration ranges that might produce differential effects on activity among allozymes of a single protein. Interspecific differences in the effect of copper on the activity of PGM-2 enzyme variants were examined for 17 fish species from seven locations. Copper was found to effect the activity of PGM-2, GPI-2, and IDH-2 enzymes in mosquitofish and intraspecific and interspecific differences existed in the copper sensitivity of enzymes in a number of the fish species tested. Allozyme phenotypes at the PGM-2 locus in mosquitofish observed on test gels (0.9 mg Cu/L) suggests that two isoalleles, one copper-tolerant and one copper-sensitive, are present at this locus. (Author's abstract)
W90-04691

COMPARISON OF ON-SITE AND LABORATORY TOXICITY TESTS: DERIVATION OF SITE-SPECIFIC CRITERIA FOR UN-IONIZED AMMONIA IN A COLORADO TRANSITION-AL STREAM.

Environmental Protection Agency, Denver, CO. Region VIII.
D. W. R. Nimmo, D. Link, L. P. Parrish, G. J. Rodriguez, and W. Wuerthele.
Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1177-1189, 1989. 1 fig, 6 tab, 41 ref.

Descriptors: *Toxicology, *Fish physiology, *Bioassay, *Colorado, *Ammonia, *Aquatic animals, *Toxicity, *Water pollution effects, Fathead minnows, Sucker, Aquatic insects, Environmental effects, Ecological effects, Wastewater, Temperature effects.

Acute tests with fathead minnows (*Pimephales promelas* Rafinesque), johnny darters (*Etheostoma nigrum* Rafinesque), white suckers (*Catostomus commersoni* Lacepede) and acute and chronic tests with *Ceriodaphnia dubia* were conducted to evaluate whether characteristics of the St. Vrain River in Colorado would ameliorate or enhance toxicity of un-ionized ammonia compared to laboratory (well) water and LC50 values found in the literature. Concurrently, tests were conducted on dilutions of Longmont, Colorado, wastewater to evaluate its toxicity in differing ammonia concentrations. Tests were conducted at two temperatures (approximately 6 and 20 °C) to simulate seasonal differences. LC50s for fishes in the St. Vrain River water were similar to LC50s in laboratory water, indicating there was no site water effect. LC50s derived for fishes tested in warm conditions were within a factor of about two or three of literature values. However, the constituents in or characteristics of the wastewater appeared to enhance ammonia toxicity. Literature values (LC50s) for resident aquatic organisms and the new LC50 value for johnny darters tested on-site were used to derive site-specific criteria for un-ionized ammonia. Greater sensitivities of species to ammonia at cold versus warm temperatures suggests that colder, low-flow conditions may be a critical period for warm-water aquatic communities with regard to ammonia toxicity. (Author's abstract)
W90-04695

SHORT- AND LONG-TERM SEDIMENT TOXICITY TEST METHODS WITH THE AMPHIPOD *GRANDIDIERELLA JAPONICA*.

Southern California Coastal Water Research Project, Long Beach.
M. G. Nipper, D. J. Greenstein, and S. M. Bay.
Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1191-1200, 1989. 1 fig, 4 tab, 29 ref. California State Water Resources Control Board Contract No. 6-214-250-0. National Research Council of Brazil Fellowship No. 20.3016/86.

Descriptors: *Toxicology, *Water pollution effects, *Sediment contamination, *Toxicity, *Amphipods, *Marine sediments, Benthos, Environmental effects, Ecological effects, Growth, Water pollution effects, Particle size, Bioassay.

Methods for the collection, culture and testing of the marine amphipod *Grandidierella japonica* are presented along with methods for conducting flow-through sediment toxicity tests. Short-term (10-day) exposures were conducted at 15 °C in 1-liter beakers containing a 2-cm layer of sediment and 700 ml overlying seawater. Long-term (28-day) tests were conducted in 1-liter beakers at 19 °C with the weekly addition of food to the test chambers. Both methods were used to measure the toxicity of sediments from five locations in southern California. These sites included highly contaminated areas adjacent to large municipal wastewater outfalls and within industrialized harbors. Both test methods were sensitive to levels of contamination found in the field, but produced different patterns of effects. Short-term mortality was greatest in amphipods exposed to the harbor sediments, while long-term exposure produced the greatest reductions in survival and growth at the Los Angeles County Outfall site. Amphipod survival was unaffected by variations in sediment grain size, while this characteristic appeared to have an important effect on growth. (Author's abstract)
W90-04696

TOXICOLOGY STUDIES OF A CHEMICAL MIXTURE OF 25 GROUNDWATER CONTAMINANTS: II. IMMUNOSUPPRESSION IN B6C3F MICE.

National Toxicology Program, Research Triangle Park, NC.
D. R. Germolec, R. S. H. Yang, M. F. Ackermann, G. J. Rosenthal, and G. A. Boorman.
Fundamental and Applied Toxicology FAATDF, Vol. 13, No. 3, p 377-387, October 1989. 4 fig, 2 tab, 38 ref.

Descriptors: *Mice, *Toxicology, *Water pollution effects, *Hazardous wastes, *Toxicity, *Groundwater pollution, Bioassay, Immunology, Organic wastes, Industrial wastes, Organic compounds, Heavy metals.

Immune function was monitored in female B6C3F mice exposed to a chemical mixture in drinking water for either 14 or 90 days. The mixture consisted of 25 common groundwater contaminants frequently found near toxic waste dumps, as determined by EPA surveys. None of the animals developed overt signs of toxicity such as body or liver weight changes. Mice exposed to the highest dose of this mixture for 14 or 90 days showed immune function changes which could be related to rapidly proliferating cells, including suppression of hematopoietic stem cells and of antigen-induced antibody-forming cells. Some of these responses, e.g., granulocyte-macrophage colony formation, were also suppressed at lower concentrations of the chemical mixture. There were no effects on T cell function or T and B cell numbers in any of the treatment groups. Altered resistance to challenge with an infectious agent also occurred in mice given the highest concentration, which correlated with the immune function changes. Paired-water studies indicated that the immune effects were related to chemical exposure and not to decreased water intake. These results suggest that long-term exposure to contaminated groundwater may represent a risk to the immune system in humans. (Author's abstract)
W90-04698

TOXICOLOGY STUDIES OF A CHEMICAL MIXTURE OF 25 GROUNDWATER CONTAMINANTS: III. MALE REPRODUCTION STUDY IN B6C3F MICE.

National Inst. of Environmental Health Sciences, Research Triangle Park, NC. Systemic Toxicology Branch.
R. E. Chapin, J. L. Phelps, B. A. Schwetz, and R. S. H. Yang.
Fundamental and Applied Toxicology FAATDF, Vol. 13, No. 3, p 388-398, October 1989. 5 fig, 3 tab, 34 ref.

Descriptors: *Water pollution effects, *Hazardous wastes, *Toxicology, *Toxicity, *Bioassay, Mice, Groundwater pollution, Kidneys, Organic wastes, Industrial wastes, Organic compounds, Heavy metals.

A mixture of chemicals that models contaminated groundwater around hazardous waste sites was given to male B6C3F mice at three different concentrations (1%, 5%, and 10% in drinking water) for 90 days. After the test period, the mice were euthanized and examined for body weight, and histology of liver, kidney, testis, epididymis and seminal vesicles. Although there was a concentration-related decrease in the amount of fluid consumed at the higher two concentrations, there were no differences in body weight among the groups. Similarly, there was no effect of mixture consumption upon the histology of liver, kidney, testis, epididymis, or seminal vesicles or upon the absolute weights of these organs. Kidney weight relative to body weight was increased in the high dose group. Epididymal sperm number and testicular spermatid count were not affected by treatment. At exposure levels that decrease fluid intake and increase adjusted kidney weight (i.e., 5% and 10% in drinking water) there were no effects of this mixture on gametogenesis in male mice. (Geiger-PTT)
W90-04699

SHORT-TERM LINDANE EFFECTS ON GILL TISSUE METABOLISM OF THE EEL.

Valencia Univ. (Spain). Dept. of Animal Physiology.

M. D. Ferrando, E. Andreu, C. Cebrian, V. Alarcon, and M. Almar.

Toxicological and Environmental Chemistry TXECBF, Vol. 25, No. 1-2, p 17-23, 1989. 3 fig, 3 tab, 14 ref. Direccion General de Investigacion Cientifica y Tecnica del Ministerio de Educacion y Ciencia Grant No. PS87-0076.

Descriptors: *Water pollution effects, *Fish physiology, *Insecticides, *Toxicity, *Lindane, *Eel, Lipids, Gills, Metabolism, Environmental effects, Bioassay, Ecological effects, Stress, Resistance.

Previous work on lindane toxicology of the European eel *Anguilla anguilla* showed that 0.67 ppm of lindane was the 50% lethal concentration at 96 hr. Lactate, cholesterol, and total lipids in eel gill tissue were analyzed after 0.167 ppm lindane treatment (1/4 LC50). Lactate levels increased significantly after 6 hr treatment with respect to the control values. Cholesterol decreased after 6 hr treatment and continued decreasing gradually until 96 hr treatment. Total lipids increased after 6 hr treatment but decreased between 12 and 96 hr. High increases in lactate concentration caused by lindane exposure suggests that energy is depleted in the eel and anaerobic pathway rates are increased as an initial response to pesticide-induced stress. Decreases in cholesterol may be related to either a disruption of plasma membranes and/or altered steroidogenesis. Present findings suggest that *A. anguilla* has inherent tissue specific resistance potentiality to withstand ambient pesticide toxicity by suitably modulating its metabolic profiles to mitigate pesticide toxicity and to increase survival capacity. (Geiger-PTT)
W90-04703

DIATOM-BASED PH RECONSTRUCTION OF LAKE ACIDIFICATION USING CANONICAL CORRESPONDENCE ANALYSIS.

Newcastle upon Tyne Univ. (England).
For primary bibliographic entry see Field 2H.
W90-04711

BACTEREMIC CELLULITIS CAUSED BY NON-SEROGROUP O1 *VIBRIO CHOLERAE* ACQUIRED IN A FRESHWATER INLAND LAKE.

Abraham Lincoln School of Medicine, Chicago, IL. Section of Infectious Diseases.
D. L. Pitrak, and J. D. Gindorf.
Journal of Clinical Microbiology JCMIDW, Vol. 27, No. 12, p 2874-2876, Dec 1989. 1 tab, 15 ref.

Descriptors: *Water pollution effects, *Human diseases, *Vibrio, *Lakes, Public health, Human pathogens, Pathogenic bacteria, Infection.

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The number of reported cases of infections with non-serogroup O1 *Vibrio cholerae* in the United States has increased recently. These cases have almost invariably been associated with travel, sea-water exposure, or the ingestion of shellfish. A case of bacteremic cellulitis caused by non-O1 *V. cholerae* that was acquired in a freshwater inland lake in northern Illinois is reported. A 34-year-old male was admitted with fever, chills, nausea, vomiting, upper abdominal pain, and pain and swelling of both lower extremities. He had been fishing in Fox Lake (a freshwater lake in northern Illinois), wading in the lake without boots, 2 days prior to admission. While wading he had fallen and abraded his shins. The next evening he awoke with fever, chills, and bilateral leg pain and swelling. Soon he developed nausea, vomiting, and upper abdominal pain. By the third hospital day, three sets of blood cultures from admission grew curved gram-negative rods identified as *V. cholerae*. Later the organism was identified as a non-serogroup O1 *V. cholerae*. This patient was exceptional in that his infection was clearly associated with freshwater exposure. Infections with non-serogroup O1 *V. cholerae* have rarely been acquired in inland regions. The organism is more widely distributed than generally appreciated, and the potential for infection in patients without the usual risk factors exists. (Shidler-PTT)
W90-04724

SULFIDE TOLERANCE AND DETOXIFICATION IN SHALLOW-WATER MARINE FISHES

Scriptis Institution of Oceanography, La Jolla, CA. Marine Biology Research Div.
For primary bibliographic entry see Field 2L.
W90-04726

MONITORING EFFECTS OF A STORM SEWER OVERFLOW UPON THE NANT FFRWD, SOUTH WALES.

Welsh Water Authority, Bridgend.
S. C. Bird, N. Reynolds, and R. Henderson.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1785-1788, 1989. 3 fig, 1 tab, 4 ref.

Descriptors: *Urban runoff, *Storm sewers, *Water pollution effects, *Rivers, *Storm-overflow sewers, *Sewers, Monitoring, Nant River, Wales, Runoff, Overflow, Dissolved oxygen, Water quality, Nitrogen, Ammonia, Aquatic life, Fish, Invertebrates, Toxicity, Outfall sewers.

Monitoring of storm sewer overflows into the Nant Ffrwd, Wales, showed peak pollutant concentrations of 20 to 200 mg/liter BOD and 1 to 10 mg/l ammonia nitrogen. These persisted for 10 minutes or less. Ammonia nitrogen in the stream increased with every spill, even minor events, to as much as 0.7 mg/l. BOD concentrations in the river peaked at about 20 mg/l. Impacts on dissolved oxygen concentrations were minimal. Toxicity to macroinvertebrates in downstream cages approached 40%. Rainbow trout densities were higher downstream of the outfall than upstream in April 1987, but the reverse was true in April 1988 and in July 1988. Rainbow trout egg bioassays in July 1988 showed no obvious impact from the overflow. (Cassar-PTT)
W90-04771

SPRAT-A SIMPLE RIVER QUALITY IMPACT MODEL FOR INTERMITTENT DISCHARGES.

Water Research Centre, Swindon (England). Swindon Engineering Centre.
C. P. Crockett, R. W. Crabtree, and H. R. Markland.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1793-1796, 1989. 4 fig, 6 ref.

Descriptors: *Urban hydrology, *Storm wastewater, *Path of pollutants, *Rivers, *Water pollution effects, *Storm-overflow sewers, *Storm water, *Model studies, SPRAT model, Flood forecasting, Overflow.

The SPRAT (Spill Pollution Response Assessment Technique) model was developed to predict the transient quality changes in receiving waters due

to intermittent storm sewage discharges. The model incorporates simplifications such as plug flow and instantaneous mixing. It does not take into account the effects of dispersion. Application of the model to the River Crol catchment proved useful in highlighting the problems in model use. Areas where more sophistication is needed include accuracy in prediction of flood wave passage, the effect of dispersion on determinand concentration, the effect of sediment scouring, and dissolved oxygen concentrations. (Cassar-PTT)
W90-04773

SELF-PURIFICATION PROCESSES ALONG A POLLUTED RIVER IN GREECE.

National Centre for Marine Research, Athens (Greece).
For primary bibliographic entry see Field 5B.
W90-04792

EFFECT OF ORGANOCHLORINE COMPOUNDS ON EXISTENCE AND GROWTH OF SOIL ORGANISMS.

National Inst. for Environmental Studies, Tsukuba (Japan).
Y. Inamori, K. Matsushige, R. Sudo, and H. Kikuchi.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1887-1890, 1989. 1 fig, 1 tab, 6 ref.

Descriptors: *Groundwater pollution, *Water pollution effects, *Chlorinated hydrocarbons, *Microorganisms, *Soil contamination, Organic compounds, Trichloroethylene, Tetrachloroethylene, Trichloroethane, Rotifers, Protozoa, Toxicity, Rotifers, Oligochaetes.

The EC50s of organochlorine compounds were determined for soil microorganisms. The compounds used were as follows: trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,1,1-trichloroethane (TCET). EC50s for *Philodina erythrophthalma* (rotifer) in mg/l were 92 for TCE, 33 for PCE, and 162 for TCET. EC50s for *Aelosoma hemprichi* (oligochaete) in mg/l were 47 for TCE, 13 for PCE, and 92 for TCET. EC50s for *Colpoda* sp. (protozoa) in mg/l were 75 for TCE, 64 for PCE, and 205 for TCET. In a survey of contaminated groundwater, it was found that over 70% of the samples had less than 1 microgram/l of organochlorine compounds. The highest concentration found in this sampling was 23,000 microgram/l PCE. With respect to EC50, soil organisms were not affected by the concentrations of organochlorine compounds usually found in groundwater. Tolerance of soil organisms to these compounds was *Colpoda* sp. > *P. erythrophthalma* > *A. hemprichi*. Toxicity of the compounds tested was PCE > TCE > TCET. The effects of the organochlorine compounds on the ability of soil organisms to degrade organic matter were expressed as the concentration causing 50% reduction in removal of organic material (mg/l) as follows: TCE, 330; PCE, 110; and TCET, 460. Control objectives relating to the prevention of soil contamination were PCE, 0.01 mg/l; TCE, 0.03 mg/l; and TCET, 0.3 mg/l. (Cassar-PTT)
W90-04796

MUTAGENIC ACTIVITY OF ORGANIC CONCENTRATES FROM MUNICIPAL RIVER WATER AND SEWAGE EFFLUENT AFTER CHLORINATION OR OZONATION.

Setunan Univ., Neyagawa (Japan). Faculty of Pharmaceutical Sciences.
K. Nakamura, H. Ueno, and Y. Sayato.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1895-1898, 1989. 4 fig, 3 ref.

Descriptors: *Water pollution sources, *Water pollution effects, *Fate of pollutants, *Water treatment, *Ozonation, *Chlorination, *Mutagenicity, *Organic matter, Rivers, Yodo River, Japan, Municipal water, Wastewater pollution, Seasonal variation.

Samples of water from the polluted Yodo River in Japan were chlorinated, ozonated or preozonated-chlorinated and the mutagenic activity of the treated water determined. The mutagenic activity was

highest in water near the sewage effluent outfall. Highest activity was in autumn, followed by spring, then summer. Ozonation was more effective in removing mutagenic substances than chlorination. The preozonation-chlorination treatment produced variable results, somewhat comparable to ozonation alone. (Cassar-PTT)
W90-04798

EUTROPHICATION IN THE NETHERLANDS.

Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
L. Lijklema, J. H. Jansen, and R. M. M. Roijackers.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1899-1902, 1989. 2 fig, 1 ref.

Descriptors: *Lake restoration, *Water pollution effects, *Lakes, *Eutrophication, The Netherlands, Water quality, Nutrients, Chlorophyll, Water quality control, Phosphorus removal, Eutrophic lakes, Nitrogen, Nitrification, Denitrification, Algae, Cyanophyta.

Water quality was studied in 121 Dutch lakes during 1983-1985. Relationships were developed between nutrient loading and nutrient concentration and between nutrient concentration and chlorophyll concentration. The equation for phosphorus loading/concentration was based on a retention coefficient dependent on concentrations in the lake and on the inflow, water depth, and hydraulic retention time. The nitrogen equation also had to consider nitrification and denitrification processes. Relationships between nutrient concentration and chlorophyll concentration showed that there was an upper limit for the chlorophyll concentration which was different for lakes dominated by filamentous blue-green algae as compared with other lakes. The blue-green algae apparently utilize phosphate very efficiently; thus, phosphate reductions must be proportionately greater in these lakes to remedy eutrophication. To achieve water quality based on maximum summer averaged chlorophyll concentrations of 100 microgram/l, maximum allowable phosphorus concentrations were set at 0.16 mg/l for normal lakes, 0.07 microgram/l for lakes dominated by filamentous blue-green algae, and/or 2.2 mg/l of nitrogen. (Cassar-PTT)
W90-04799

WHOLE LIFE HISTORY STUDIES OF COHO SALMON (*Oncorhynchus kisutch*) FOLLOWING EMBRYONIC EXPOSURE TO BENZO(A)PYRENE.

Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
G. K. Ostrander, M. L. Landolt, and R. M. Kocan.
Aquatic Toxicology AQTOGD, Vol. 15, No. 2, p 109-126, August 1989. 4 fig, 5 tab, 33 ref. US EPA Grant R-81348.

Descriptors: *Salmon, *Life history studies, *Benzo(a)pyrene, *Fish behavior, *Toxicity, *Water pollution effects, *Embryonic growth stage, *Sublethal effects, Animal pathology, Hydrocarbons, Bioassay, Metabolism, Respiration, Fish migration.

It was previously found that a single embryonic exposure of salmonid embryos to benzo(a)pyrene was capable of inducing subtle behavioral changes following hatching. This study determines whether coho salmon which had survived an identical benzo(a)pyrene exposure were capable of successfully competing with their normal counterparts under natural conditions. Common exposure levels used during the tests were 7, 10 and 25 micrograms benzo(a)pyrene/ml water. The uptake and retention of benzo(a)pyrene was examined, as well as the ability of this compound to compromise normal metabolic activity. No significant changes or alterations in embryonic or larval respiration were seen. Subsequently, hatchery reared coho salmon, which return to their site of birth when sexually mature, were exposed to benzo(a)pyrene at one of two stages of embryonic development. These fish, as well as appropriate controls, were individually tagged prior to release for seaward migration. As fish returned from the sea, length,

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weight, sex, and pathology were compared among the groups. Nearly identical numbers of fish returned among control and exposure groups and no significant differences were seen in parameters measured. Histopathological examination failed to detect any abnormalities. However, these exposed fish were grown in the relatively safe confines of a hatchery, and were fed constantly and did not have to hunt for prey. They were given ample time to recover from the deleterious effects of exposure before returning to the wild. (Author's abstract) W90-04825

ALLOZYME GENOTYPE AND TIME TO DEATH OF MOSQUITOFISH, *GAMBUSIA AFFINIS* (BAIRD AND GIRARD) DURING ACUTE TOXICANT EXPOSURE: A COMPARISON OF ARSENATE AND INORGANIC MERCURY.

Savannah River Ecology Lab., Aiken, S.C. M. C. Newman, S. A. Diamond, M. Mulvey, and P. Dixon. Aquatic Toxicology AQOTODG, Vol. 15, No. 2, p 141-156, August 1989. 1 fig, 5 tab, 42 ref. US DOE Contract DE-AC09-76SR00819.

Descriptors: *Enzymes, *Genotoxicity, *Toxicity, *Water pollution effects, *Gambusia, *Arsenic, *Mercury, *Genetics, *Tolerance, *Animal pathology, *Heavy metals, *Bioassay, *Fish, *Mortality, *Population exposure, *Comparison studies.

Fish were exposed to arsenic (93 to 94 mg As/L versus < 2 mg/L for controls) for up to 102 hours in a flow-through exposure system. Genotypic frequencies at 8 enzyme loci were examined in the population of mosquitofish, *Gambusia affinis* (Baird and Girard) during acute arsenate exposure. Genotypes at 2 loci (fumarate hydratase and glucose-phosphate isomerase-2) and multiple locus heterozygosity (male fish) were significantly correlated with time to death (TTD). The results from arsenate exposures were contrasted with those reported earlier for acute inorganic mercury exposure. Earlier TTD were associated with a rare homozygous genotype for the Gpi-2 locus in both arsenate and inorganic mercury exposures; however, no other single locus effect on TTD was common to both toxicants. Difference in TTD associated with genotypic variation, therefore, can be a specific for the toxicant (Fh, Icd-1 and Mdh-1) or a nonspecific response to chemical stressors (Gpi-2). The results of acute exposures of mosquitofish to mercury and arsenate suggest that most of the effects of multiple locus heterozygosity can be attributed to the summation of single locus effects. (Author's abstract) W90-04826

QSAR-ANALYSIS OF ACUTE TOXICITY OF INDUSTRIAL POLLUTANTS TO THE GUPPY USING MOLECULAR CONNECTIVITY INDICES.

Instituut CIVO-Toxicologie en Voeding TNO, Zeist (Netherlands). D. C. Leegwater. Aquatic Toxicology AQOTODG, Vol. 15, No. 2, p 157-168, August 1989. 2 fig, 4 tab, 8 ref.

Descriptors: *Lethal limit, *Industrial wastes, *Water pollution effects, *Toxicity, *Molecular structure, *Structure-activity relationships, *Chemical wastes, *Guppies, *Mathematical analysis, *Pollutants, *Regression analysis, *Aromatic compounds, *Chlorinated hydrocarbons, *Mortality, *Physical properties, *Octanol-water partition coefficient, *Regression analysis.

A comparative study was made of the use of log P values and molecular connectivity indices to predict the acute toxicity (LC50) of a variety of industrial pollutants to the guppy by means of (multiple) regression analysis. 59 aromatic compounds, 18 aliphatic chloro, and 15 aliphatic oxygen compounds were studied. It was found that quantitative structure-activity relationships (QSARs) based on chi(2)v or a combination of chi(0)v, chi(0), and a dummy variable for the presence of a benzene ring were equivalent and sometimes even superior to those based on log P values. The LC50 value of a great variety of industrial pollutants for the guppy can satisfactorily be pre-

dicted by regression equations based on molecular connectivity indices. Further work is required to establish what kind of topological and/or electronic information encoded in the indices chi(2)v and the combination chi(0)v-chi(0) made them so suitable as descriptors in this study. (Author's abstract) W90-04827

RENAL HISTOPATHOLOGICAL CHANGES IN THE GOLDFISH (*CARRASSIUS AURATUS*) AFTER SUBLETHAL EXPOSURE TO HEXACHLOROBUTADIENE.

Maryland Univ. at Baltimore. Dept. of Pathology. R. Reimschuessel, R. O. Bennett, E. B. May, and M. M. Lipsky. Aquatic Toxicology AQOTODG, Vol. 15, No. 2, p 169-180, August 1989. 2 fig, 1 tab, 48 ref.

Descriptors: *Animal tissues, *Water pollution effects, *Animal pathology, *Fish physiology, *Goldfish, *Kidneys, *Chlorinated hydrocarbons, *Sublethal effects, *Hexachlorobutadiene, *Bioassay, *Biochemistry.

Hexachlorobutadiene (HCBD), a chlorinated hydrocarbon, is an acute renal toxicant in mammals. Goldfish (*Carassius auratus*) were given a single ip injection of a sublethal dose (500 mg/kg) of HCBD and sampled daily for one week. No damage was observed by light microscopy 6 hours post injection. At 24 hours, however, cytoplasmic vacuolation and necrosis occurred in the renal tubules. This damage was localized to the epithelium of the second (P2) and third (P3) segments of the proximal tubule. The damage persisted for seven days. By the sixth day the first segment (P1) of the proximal tubule had small cytoplasmic vacuoles. The ratio of kidney to body weight was significantly greater in the treated fish on the fourth day. Gamma glutamyl transpeptidase (GGT), a histochemical marker of proximal tubule brush border in mammals, was demonstrated in the goldfish kidney. Intense staining was noted only in P2 and P3. GGT staining was also present in the lumen of the damaged, vacuolated tubules of HCBD-treated fish. It is interesting to note that the renal proximal tubules which demonstrated intense GGT activity were the most sensitive to HCBD toxicity. GGT is involved in the breakdown to the glutathione conjugate to its cysteine conjugate. This may be one actor in the effect of HCBD on the goldfish proximal tubules. (Author's abstract) W90-04828

EFFECT OF A HERBICIDE, CHLORINITROFEN (2,4,6-TRICHLOROPHENYL-4'-NITROPHENYL ETHER), ON THE GROWTH AND REPRODUCTION OF THE GUPPY (*POECILIA RETICULATA*) THROUGH WATER AND FOOD.

National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div. S. Hatakeyama. Aquatic Toxicology AQOTODG, Vol. 15, No. 2, p 181-196, August 1989. 5 fig, 5 tab, 13 ref.

Descriptors: *Fish growth, *Spawning, *Guppies, *Herbicides, *Reproduction, *Water pollution effects, *Toxicity, *Food chains, *Growth, *Tubificids, *Path of pollutants, *Chlorinitrofen, *Animal pathology, *Sublethal effects, *Fry, *Bioassay.

Young guppies (30 day old *Poecilia reticulata*) were exposed to formulation chlorinitrofen (CNF; 20% CNF, 72% xylene and 8% emulsion) for 28 days. Surviving fry were 16% and 51% of the control number in the first and second parturition at 25 ug/L CNF. Normal parturition did not occur at 125 ug/L. Young guppies were also exposed to 200 ug/L CNF for 1 to 7 days. The number of fry decreased to 50% of controls in guppies exposed to formulation CNF for 1 day, while the same effect was observed with 3 days exposure (also at 200 ug/L) using the reagent grade (99%) CNF. In a third experiment, guppies were exposed to CNF for 30 days through a CNF accumulated tubifex. The number of fry decreased as CNF concentrations of the tubifex decreased. At the maximum concentration (160 ug CNF/g, wet weight), a cumulative number of fry decreased to 23, 43 and 49% of the control group in the first, second and

third month, respectively. CNP concentrations in the liver and female gonads were high. The retention time of CNP accumulated in the female gonad was longer than that in the liver. (Author's abstract) W90-04829

EPIDEMIOLOGY AND TOXICOLOGY OF VOLATILE ORGANIC CHEMICAL CONTAMINANTS IN WATER ABSORBED THROUGH THE SKIN.

National Academy of Sciences, Washington, DC. R. D. Thomas. Journal of the American College of Toxicology JACTDZ, Vol. 8, No. 5, p 779-795, October 1989. 1 fig, 6 tab, 72 ref.

Descriptors: *Path of pollutants, *Epidemiology, *Toxicity, *Volatile organic compounds, *Epidermis, *Chlorination, *Literature review, *Water pollution effects, *Population exposure, *Human population, *Organic compounds, *Liver, *Kidneys, *Blood.

This paper provides a general introduction to the occurrence, epidemiology, and toxicity of some of the most common contaminants of water supplies, the volatile organic chemicals (VOCs). VOCs are formed from the reaction of chlorine during disinfection with naturally occurring carbon in the form of humic acids. The VOCs may also enter water supplies as a result of manufacturing, processing, distribution, and urban and agricultural runoff. Their occurrence is summarized. No epidemiologic studies examine the health effects where skin is the sole route of exposure. However, several studies are reviewed where skin is one of the routes of exposure for VOCs. Finally, the toxicity of some of the more important VOCs is outlined, including chloroform, trichloroethylene, tetrachloroethylene, carbon tetrachloride, benzene, and alkybenzenes. Where possible, similarities in toxicity between individual members of this class of chemical contaminants are noted. There are striking similarities of toxicity of various VOCs in the liver, kidney, and hematopoietic system. These similarities should be considered as skin exposure models are being developed. (Author's abstract) W90-04830

HUMAN SKIN BINDING AND ABSORPTION OF CONTAMINANTS FROM GROUND AND SURFACE WATER DURING SWIMMING AND BATHING.

California Univ., San Francisco. Dept. of Dermatology. For primary bibliographic entry see Field 5B. W90-04832

PREDICTION OF LONG-TERM EFFECTS OF RAINWATER ACIDITY ON PEAT AND ASSOCIATED DRAINAGE WATER CHEMISTRY IN UPLAND AREAS.

Aberdeen Univ. (Scotland). Dept. of Plant and Soil Science. U. Skiba, and M. Cresser.

Water Research WATRAG, Vol. 23, No. 12, p 1477-1482, December 1989. 7 fig, 3 tab, 10 ref.

Descriptors: *Acid rain effects, *Water chemistry, *Acid rain, *Air pollution effects, *Peat soils, *Drainage water, *Soil chemistry, *Rainfall-runoff relationships, *Hydrogen ion concentration, *Prediction, *Cations, *Surface runoff, *Catchment areas, *Scotland.

The effect of precipitation pH upon the chemistry of peat and associated drainage waters has been investigated using a multiple stir and centrifuge technique. Samples of upland blanket peats were collected from moorland sites in northeast and southeast Scotland. A stir and centrifuge technique was adopted to simulate prolonged rainfall effects because peat is often highly impermeable. Both peats behaved in a similar way when treated with up to 2000 mm of 'rain' with varying degrees of acidity. Resulting changes were most pronounced for drainage water and peat pH, and peat and water Ca and Mg concentrations. The results indi-

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cate that atmospheric acidifying pollutants have lowered the pH of fresh waters by more than one unit in catchments where the predominant hydrological pathways are surface runoff and near-surface throughflow over impermeable peats. Improvements in pH resulting from emission reductions should be detectable in such catchments within a few years. Base cation concentrations in deposition are also important, however, because the controlling mechanism is cation exchange. (Author's abstract)
W90-04834

EFFECT OF WASTEWATER SPRAY IRRIGATION ON ROTAVIRUS INFECTION RATES IN AN EXPOSED POPULATION.

James N. Gamble Inst. of Medical Research, Cincinnati, OH.

For primary bibliographic entry see Field 5D.
W90-04838

PROBLEMS CONCERNING MARINE EUTROPHICATION, (PROBLEMES CONCERNANT L'EUTROPHISATION MARINE).

Institutul Roman de Cercetari Marine, Constanta (Romania).

M. T. Gomoiu.
Cercetari Marine: Recherches Marines, Vol. 18, p 59-95, 1985. 9 fig, 1 tab, 94 ref. English summary.

Descriptors: *Water pollution effects, *Eutrophication, *Marine pollution, *Marine biology, *Black Sea, *Romania, Nutrients, Plankton, Algae, Species diversity, Fish populations.

Based on a literature review and an analysis of the present state of the Black Sea coastal ecosystem, the problems concerning marine eutrophication are addressed. The meaning of 'marine eutrophication' as it applies to the Black Sea, and particularly the Romanian coast, has been summarized as follows: (1) an increase in the quantities of nutrients; (2) an increase in phytoplankton and the appearance of red-tide chronically and at increasingly higher levels; (3) an increase in the quantities of dissolved and particulate organic matter both in sea water and the sediments; (4) the appearance of hypoxic and anoxic conditions; (5) a decrease in the number of zooplanktonic species along with an increase in the density of the dominant species; (6) the disappearance or decrease in the populations of *Zostera* or brown algae (*Cystoseira*) and red algae (*Phyllophora*) and the development of some species of green algae (*Enteromorpha*, *Cladophora*); (7) mass mortalities of some benthic organisms and modifications in the qualitative and quantitative structure of bottom associations; and (8) modifications in the structure of both fish populations and mammals (severe reduction of sturgeon stocks, the increase in the quantities of planktonofagous species; the decrease in the dolphin stock, etc.). More complex studies are necessary for understanding and defining the marine eutrophication process and for taking measures to limit over-fertilization or marine pollution. (Author's abstract)
W90-04854

DISTRIBUTION OF CHLOROPHYLL A, PHAEOPHYTIN A AND PRIMARY PRODUCTION IN THE WESTERN BLACK SEA.

Institutul Roman de Cercetari Marine, Constanta (Romania).

For primary bibliographic entry see Field 2L.
W90-04855

CHARACTERISTICS OF THE QUANTITATIVE DEVELOPMENT AND THE STRUCTURE OF THE PHYTOPLANKTON ON THE ROMANIAN SHORE FROM 1983-1985. (CARACTERISTICILE DE DEZVOLTAREA CANTITATIVĂ ȘI DE LA STRUCTURA DU PHYTOPLANKTON DES EAUX DU LITTORAL ROUMAIN PENDANT LA PERIODE 1983-1985).

Institutul Roman de Cercetari Marine, Constanta (Romania).

For primary bibliographic entry see Field 2L.
W90-04856

PHYTOPLANKTON DIVERSITY INDICES AS EUTROPHICATION INDICATORS OF THE ROMANIAN INSHORE WATERS.

Institutul Roman de Cercetari Marine, Constanta (Romania).

P. E. Mihnea.

Cercetari Marine: Recherches Marines, Vol. 18, p 139-155, 1985. 5 fig, 7 tab, 16 ref.

Descriptors: *Romania, *Water pollution effects, *Black Sea, *Phytoplankton, *Eutrophication, Species diversity, Community structure, Algal blooms.

One thousand three hundred ninety-six phytoplankton samples from the Romanian inshore waters were analyzed during 1979-1983 and 1985. The structure of the phytoplankton community from a eutrophic area was analyzed using species number, dominance, total density, diversity indices, and evenness. The result of this structure analysis indicates that the phytoplankton community is characterized by low species diversity and evenness values indicating instability. The tendency to develop 1-3 dominant species out of a total of 10-30 species is characteristic of blooms and other natural succession sequences. Few situations were observed where the diversity values were over 4, evenness was greater than 0.6, there were up to 53 species, 1-4 dominants made up a low percentage of the community, and densities were low. Events with these characteristics (indicating a stable community) were found only as a consequence of active physical changes such as strong winds. (White-Reimer-PTT)
W90-04857

SOME PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON (*SALMO SALAR*) EXPOSED TO SOFT, ACIDIC WATER DURING SMOLTING.

Department of Fisheries and Oceans, Halifax (Nova Scotia), Biological Sciences Branch.

G. J. Farmer, R. L. Saunders, T. R. Goff, C. E. Johnston, and E. B. Henderson.
AquaCulture AQCLAL, Vol. 82, No. 1-4, p 229-244, November 1989. 5 fig, 3 tab, 20 ref.

Descriptors: *Acid rain effects, *Fish physiology, *Fish stocking, *Salmon, Hydrogen ion concentration, Calcium, Salinity, Sodium, Potassium, Survival, Bioassay.

A number of physiological responses of juvenile Atlantic salmon held in water of low calcium content and pH of 4.6, 5.0, or 5.5 were measured during a 112-day period. Plasma osmolality and plasma Na^+ , Cl^- and Ca^{2+} concentrations for salmon exposed to pH 4.6 were significantly lower than for salmon exposed to pH 5.0 or 5.5. Conversely, the osmolality of urine collected from salmon exposed to pH 4.6 was greater than observed for urine collected from salmon in the other pH regimes. A significant increase in the hematocrit and plasma protein concentration of salmon exposed to pH 4.6 suggests that their plasma volume was reduced. Although the lipid content of salmon exposed to the various pH regimes was not different, both condition factor and moisture content of salmon exposed to pH 4.6 were lower than for salmon exposed to pH 5.0 or 5.5. Neither branchial Na^+ , K^+ ATPase activity nor tolerance to a salinity of 37.5‰ increased during the spring among salmon exposed to pH 4.6 as was observed for salmon exposed to pH 5.0 or 5.5. The cumulative proportion of the salmon that survived 112 days of exposure to pH 4.6, 5.0, and 5.5 was 0.28, 0.98, and 1.0, respectively. Attempts to augment salmon populations or to recolonize previously inaccessible areas by the release of hatchery-reared parr and smolts can be expected to be successful for rivers which have a pH of about 5.5 and to be somewhat less successful for rivers which have a pH of 5.0. Success will decrease as pH declines below 5.0 so that no survival of parr or smolts can be expected when pH is 4.6 or less. (Author's abstract)
W90-04858

LAKE TAHOE: PRESERVING A FRAGILE ECOSYSTEM.

California Univ., Davis. Div. of Environmental Studies.

For primary bibliographic entry see Field 2H.
W90-04866

UPTAKE AND DEPURATION OF ^{241}Am , $^{239+240}\text{Pu}$, ^{137}Cs AND ^{106}Ru BY *MYTILUS EDULIS* UNDER NATURAL STRESS.

Marine Biological Association of the United Kingdom, Plymouth (England).

For primary bibliographic entry see Field 5B.
W90-04869

MICRO-ALGAE OF LAKE PUPUKE, AUCKLAND, NEW ZEALAND.

Department of Scientific and Industrial Research, Auckland (New Zealand). Botany Div.

For primary bibliographic entry see Field 2H.
W90-04873

EVIDENCE FOR FLUORIDE EFFECTS ON SALMON PASSAGE AT JOHN DAY DAM, COLUMBIA RIVER, 1982-1986.

National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center.

D. M. Damkaer, and D. B. Dey.
North American Journal of Fisheries Management NAJMDP, Vol. 9, No. 2, p 154-162, Spring 1989. 3 fig, 3 tab, 20 ref.

Descriptors: *Water pollution effects, *Fluorides, *Fish passages, *Columbia River, Salmon, Fish migration, Survival, Industrial wastes, Dams.

There is evidence that fluoride from an aluminum plant near John Day Dam had a significant negative effect on passage time and survival of adult Pacific salmon *Oncorhynchus* species at the dam. In 1982, fluoride concentrations of 0.3-0.5 milligrams per liter were recorded at the dam. These concentrations were probably representative of fluoride levels at the dam in earlier years as well, based on the aluminum plant's fluoride discharge records since 1971. From 1980 to 1982, the time (more than 150 hours) required for upstream migrants to pass John Day Dam and the mortality (greater than 50%) of migrants between Bonneville and McNary dams (below and above John Day Dam) were unacceptably high. Bioassay experiments on the behavior of upstream-migrating adult salmon suggested that fluoride concentrations of about 0.5 milligrams per liter would adversely affect migration. Subsequent experiments suggested that 0.2 milligrams fluoride per liter was at or below the threshold for fluoride sensitivity of chinook salmon *O. tshawytscha* and below the threshold for fluoride sensitivity of coho salmon *O. kisutch*. Beginning in 1983 and continuing through 1986, fluoride discharges from the aluminum plant were greatly reduced and there was a corresponding drop in fluoride concentrations in the river. Concurrently, fish passage delays and interdam losses of adult salmon decreased to acceptable levels (28 hours and less than 5 percent, respectively). (Author's abstract)
W90-04915

TOXICITY OF MICROCYSTIS SPECIES ISOLATED FROM NATURAL BLOOMS AND PURIFICATION OF THE TOXIN.

Ibaraki Univ., Ami (Japan). Dept. of Agricultural Chemistry.

A. Ohtake, M. Shirai, T. Aida, N. Mori, and K. I. Harada.

Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3202-3207, December 1989. 6 fig, 2 tab, 20 ref.

Descriptors: *Algal toxins, *Toxins, *Algae, *Cyanophyta, *Microcystis, *Japan, *Eutrophic lakes, Toxicity, Lakes, Lethal limit, Water pollution effects, Liver.

Microcystis strains (2 toxic and 18 nontoxic to mice) were isolated from toxic waterblooms that had been collected from Lake Kasumigaura, Ibaraki Prefecture, Japan, in August 1985. Thirteen of the strains (2 toxic and 11 nontoxic) were Micro-

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cystis aeruginosa, 2 (nontoxic) were *Microcystis wessenbergii*, and the other 5 were difficult to identify. Six (1 toxic and 4 nontoxic *M. aeruginosa* and 1 *M. wessenbergii*) of these 20 strains were established as axenic cultures. A toxic and axenic strain of *M. aeruginosa*, K-139, was used to study the relationship between growth conditions and toxicity. Cells in early-to-mid-log phase showed the highest toxicity (50% lethal dose, 7.5 mg of cells per kg of mouse), and maximum toxicity was not affected by growth temperatures between 22 and 30 °C. Purification and characterization of the toxins from K-139 cells were also conducted, and at least two toxins were detected. One of the toxins (molecular mass, 980 daltons) has not been reported previously. The main target of the toxin in mice was the liver. Marked congestion and necrosis in the parenchymal cells around the central veins of the liver were observed microscopically in specimens that had been prepared from the mice with acute toxicity after injection with the toxin. (Author's abstract) W90-04935

CADMIUM EFFECTS ON PLAICE LIVER XENOBIOTIC AND METAL DETOXICATION SYSTEMS: DOSE-RESPONSE.

Stirling Univ. (Scotland). School of Biological and Molecular Sciences.

S. G. George.

Aquatic Toxicology AQTOGDG, Vol. 15, No. 4, p 303-310, December 1989. 3 fig, 1 tab, 16 ref.

Descriptors: *Toxicology, *Cadmium, *Toxicity, *Fish, *Fish physiology, *Water pollution effects, *Flounders, *Pleuronectes, *Heavy metals, *Immunological studies, *Bioassay, *Liver, *Enzymes.

The effects of intraperitoneal administration of varying doses of cadmium on hepatic metal and xenobiotic detoxication systems in the plaice, *Pleuronectes platessa*, were studied. The results showed that above a threshold of about 2 microgram Cd/g liver, metallothionein levels were increased, but at high doses the sequestration capacity of induced metallothionein was exceeded and at the highest dose tested (1 mg Cd/kg) metallothionein induction/synthesis was reduced and hepatic Zn levels decreased. Cadmium injection strongly reduced cytochrome P-450 dependent ethoxresorufin O-deethylase activity and preliminary immunological studies indicated that this was due to a decrease in enzyme protein rather than direct inhibition of activity by Cd. At the sampling time of this study (6 days) there was no significant alteration in activity of the phase II enzyme, glutathione-S-transferase. (Author's abstract) W90-04938

RELATIVE SENSITIVITY OF CERIODAPHNIA DUBIA LABORATORY TESTS AND POND COMMUNITIES OF ZOOPLANKTON AND BENTHOS TO CHRONIC COPPER STRESS.

Miami Univ., Oxford, OH. Dept. of Zoology.

M. V. Moore, and R. W. Winner.

Aquatic Toxicology AQTOGDG, Vol. 15, No. 4, p 311-330, December 1989. 7 fig, 2 tab, 31 ref.

Descriptors: *Mollusks, *Toxicology, *Aquatic insects, *Toxicity, *Copper, *Snails, *Water pollution effects, *Zooplankton, *Urologena, *Daphnia, *Rotifers, *Ceriodaphnia test, *Testing procedures, *Mayflies, *Midges, *Bioassay, *Copepods.

In situ enclosure experiments were conducted in a pond in southwestern Ohio during spring, 1987, to evaluate the effects of copper on zooplankton and benthos. Total copper concentrations (0, 20 and 40 microgram/L) were maintained in enclosures for a 5-week period. In the laboratory, 7-day *Ceriodaphnia* tests were also conducted to evaluate this test's ability to predict copper-induced changes in field enclosure communities. Colonies of the alga, *Urologena*, were significantly lower in 20 and 40 microgram/L copper treatments than in controls. The benthos community included snails, fingernail clams, mayflies, and midges, but densities of only small mayflies and chironomids were affected by copper (40 microgram/L). The zooplankton community was strongly affected by both copper concentrations. Rotifers and cyclopoid and calanoid

copepods exhibited significant reductions in density in both copper treatments. *Daphnia*, however, achieved highest densities in the 20 microgram/L copper treatment and completely disappeared from controls. This unexpected response was accurately predicted by the 7-day *Ceriodaphnia* test, but this same test did not predict that other taxa would be more sensitive than *Daphnia*. It was concluded that community responses are complex and cannot be reliably predicted with single-species toxicity tests. (Author's abstract) W90-04939

THERMAL MODULATION OF BENZO(a)PYRENE METABOLISM BY THE GULF TOADFISH, OPSANUS BETA.

Simon Fraser Univ., Burnaby (British Columbia). Environmental Toxicology Program.

C. J. Kennedy, K. A. Gill, and P. J. Walsh.

Aquatic Toxicology AQTOGDG, Vol. 15, No. 4, p 331-334, December 1989. 4 fig, 2 tab, 31 ref. NIH grant ES-04361.

Descriptors: *Fish physiology, *Toxicity, *Toxicology, *Benzo(a)pyrene, *Water pollution effects, *Benzenes, *Fish, *Chromatography, *Toadfish, *Bioassay, *Carcinogens, *Sublethal effects.

Gulf toadfish, *Opsanus beta*, were exposed to initial (14C)benzo(a)pyrene concentrations of 5 microgram/L at acclimation temperatures (18 or 28 °C) or following an acute temperature change (18 to 28 °C or 28 to 18 °C) in a simple static exposure system. At 24 hours, fish were sacrificed and the bile was analyzed by high-performance liquid chromatography for Phase I and Phase II metabolites of (14C)benzo(a)pyrene. Toadfish can metabolize (14C)benzo(a)pyrene rapidly, as very low levels of parent compound were detected, and the overall rate of uptake and metabolic processing of (14C)benzo(a)pyrene was higher in fish exposed at high temperatures. There were no significant differences between temperature treatments in the proportions of organic soluble and aqueous soluble metabolites, which contributed approximately 7.8 and 92%, respectively. A variety of Phase I metabolites were produced by toadfish, and the major Phase I metabolite identified was benzo(a)pyrene 7,8-dihydrodiol. There were significant quantitative differences between temperature treatments in the classes of Phase I metabolites produced. Fish acclimated to high temperature produced more triols and tetrols (breakdown products of highly carcinogenic (14C)benzo(a)pyrene diol epoxides) than did fish acclimated to low temperature regardless of exposure temperatures. Thus, in addition to increasing rate of uptake, higher temperatures appear to lead to a shift in metabolism towards potentially more carcinogenic intermediates. (Author's abstract) W90-04940

CONTAMINANT-INDUCED CHANGES IN THE STRUCTURE OF THE DIGESTIVE EPITHELIUM OF MYTILUS EDULIS.

Marine Biological Association of the United Kingdom, Plymouth (England).

D. M. Lowe, and K. R. Clarke.

Aquatic Toxicology AQTOGDG, Vol. 15, No. 4, p 345-358, December 1989. 3 fig, 3 tab, 34 ref.

Descriptors: *Water pollution effects, *Oil pollution, *North Sea, *Toxicity, *Toxicology, *Mussels, *Norway, *Mollusks, *Hydrocarbons, *Spectroscopy, *Physiology, *Mytilus, *Lysosomes, *Bioassay, *Lipids.

Exposure to the water accommodated fraction of North Sea crude oil has been shown to result in the formation of pathologically enlarged lysosomes in the digestive epithelium of *Mytilus edulis*. This study examines and quantifies alterations in the digestive epithelial cells of mussels, following exposure to a mixture of hydrocarbons and copper under mesocosm conditions. Mussels (*Mytilus edulis*) were collected from a population on the east shore of Oslofjord and placed in cages in two experimental systems, control and contaminated, at the Marine Research Station, Solbergstrand, Norway. The control condition had a background level of hydrocarbons in the water of about 3.0

microgram/L and the contaminated experimental system contained a mixture of copper (water concentration of 22.6 microgram/L) and hydrocarbons derived from diesel oil (124.5 +/- 65.3 microgram/L); this analysis of total hydrocarbons was by fluorescence spectrometry. Following a period of exposure of 25 days, 17 mussels were removed from each of the two conditions and the digestive glands were excised, sliced and microscopically examined. The results indicate that exposure induced pathological changes in the digestive and basophil cells, including alterations in the lysosomal vacuolar system and a reduction in the volume density of the digestive epithelium, combined with an increase in its specific surface. Other alterations included an increase in the basophil cell complement of the digestive epithelium as well as abnormal accumulation of lipids in both digestive and basophil cells. (Mertz-PTT) W90-04941

EFFECTS OF NUTRIENTS AND GRAZERS ON PERIPHYTON PHOSPHORUS IN LAKE ENCLOSURES.

Waterloo Univ. (Ontario). Dept. of Biology.

For primary bibliographic entry see Field 2H.

W90-04950

COMBINED EFFECTS OF CHLORINE AND AMMONIA ON LITTER BREAKDOWN IN OUTDOOR EXPERIMENTAL STREAMS.

Minnesota Univ., St. Paul. Dept. of Forest Resources.

R. M. Newman, and J. A. Perry.

Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 69-78, November 1, 1989. 2 fig, 3 tab, 25 ref. U.S. EPA contract CR 812468-01-1 and Minnesota Agricultural Experiment Station Project 42-025.

Descriptors: *Chlorination, *Crisp pondweed, *Ammonia, *Stream pollution, *Water pollution effects, *Detritus, *Bacteria, *Decomposing organic matter.

The response of *Potamogeton crispus* L. breakdown to controlled doses of different levels of chlorine and chlorine + ammonia was investigated over two years in outdoor experimental streams. In 1985, downstream riffles of two streams were dosed at about 10 micrograms/L Total Residual Chlorine, one stream at 64 micrograms/L Total Residual Chlorine and one stream at 230 micrograms/L Total Residual Chlorine. Two control streams were not dosed and the upstream riffles of each stream served as within stream controls. In 1986, the downstream riffle of one stream was dosed at 70 microgram/L Total Residual Chlorine and a second stream was dosed at 200 microgram/L Total Residual Chlorine. Four streams were also dosed with 2.5 mg/L NH₃-N: one stream with no chlorine, one stream with about 10 microgram/L Total Residual Chlorine, one with 56 microgram/L Total Residual Chlorine, and one with 150 microgram/L Total Residual Chlorine. A seventh stream was dosed for 2 hours at 2000 microgram/L Total Residual Chlorine and 2.5 mg/L ammonia and then allowed to recover (recovery stream). Each year, litter decomposition was measured during two 35 day trials (June-July and August-September) of the upstream (control) rate. No other chlorine effects were found during this period. In June-July 1986, there was significantly lower decomposition in the downstream dosed sites of the 200 mg/L Total Residual Chlorine alone stream, the 146 microgram/L Total Residual Chlorine + ammonia stream and the recovery stream; downstream decay rates were 56%, 42%, and 64% (respectively) of the upstream control sites. No other up-down pairs were different in July 1986. In August-September, all three streams with chlorine + ammonia and the 70 microgram/L alone stream had significantly lower decomposition rates in the downstream dosed sites. For these streams, downstream decay rates ranged from 46% (high chlorine + ammonia) to 73% (low chlorine + ammonia) of the upstream control rates. Up and downstream sites of the stream dosed with 2.5 mg/L ammonia alone were nearly identical for both trials. These results indicate that Total Residual Chlorine at less than 250 microgram/L can signifi-

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cantly reduce litter decomposition and strongly suggest that addition of ammonia to chlorinated water can increase the toxic effect of chlorine. (Author's abstract)
W90-04959

EFFECTS OF COOLING WATER DISCHARGE ON THE STRUCTURE AND DYNAMICS OF EPILITHIC ALGAL COMMUNITIES IN THE NORTHERN BALTIC.

Uppsala Univ. (Sweden). Inst. of Ecological Botany.
P. J. M. Snoeijs, and I. C. Prentice.
Hydrobiologia HYDRB8, Vol. 184, No. 1/2, p 99-123, November 1, 1989. 12 fig, 3 tab, 78 ref, append.

Descriptors: *Water pollution effects, *Sweden, *Nuclear powerplants, *Thermal pollution, *Algae, Species composition, Gulfs, Diatoms, Seasonal variation, Temperature effects, Light intensity, Cyanophyta, Rhodophyta, Chlorophyta, Phaeophyta, Canonical correspondence analysis.

The Forsmark Biotest Basin is located on the east coast of Sweden at the southern end of the Gulf of Bothnia. The Basin is a shallow coastal ecosystem that receives brackish cooling water discharge from a nuclear power plant. The effects of the discharge on epilithic algal communities were investigated by analyzing samples taken every third week throughout one year at 11 sites differentially affected by temperature and/or flow rate enhancement. Community variation was summarized in a canonical correspondence analysis of species abundances as a function of site and date. The temperature increase favored blue-green algae at the expense of red and brown algae. Blue-green algae were abundant in summer in stagnant water, whether heated or not, and some red and brown algae became abundant in winter in heated sites with flowing water. Green algae and diatoms increased in biomass in the heated sites, but not in relative cover-abundance. The absence of ice and snow cover at sites with heated and/or flowing water caused autumn species to persist into winter, because of the higher light intensity (compared with natural conditions) and the absence of the mechanical abrasion by ice. The thermal discharge lowered species diversity both in summer and winter at sites with flowing water, but not at sites with quiescent or stagnant water. Canonical correspondence analysis showed alternate periods of stability and rapid change within the seasonal cycle. Individual species were placed according to their optimum; red and brown algae in winter/spring, green algae in spring/summer, blue-green algae in summer, and diatoms at various times. Exceptions to this pattern were species endophytic or epiphytic on species of a different group. Analysis of the effects of temperature, flow rate and ice cover on the seasonal pattern of particular species showed that different species respond in individualistic ways to different combinations of these environmental variables. (Author's abstract)
W90-04960

EFFECTS OF SAN FRANCISCO BAY WATER QUALITY ON ADJACENT PROPERTY VALUES.

Environmental Defense Fund, Oakland, CA.
D. Kirshner, and D. Moore.
Journal of Environmental Management JEWMAW, Vol. 29, No. 3, p 263-274, October 1989. 4 tab, 16 ref.

Descriptors: *Water quality, *Property value, *California, *San Francisco Bay, *Water pollution effects, Economic aspects.

The San Francisco Bay and Delta is an estuarine system fed largely by freshwater flows from the Sacramento and San Joaquin rivers. The environmental and economic effects that result from diversions of these freshwater flows to agricultural and urban users are currently under review by the State regulatory agency. This study examined the selling prices of residential real estate in two areas adjacent to different parts of the San Francisco Bay that differ in water quality. Hedonic property value equations were used to estimate the value of

proximity to water in each of the areas. Comparison of the estimates produced a statistically significant value placed by residents on better water quality. The implicit marginal price of proximity to water is estimated to be \$65,000 (1985 dollars), or 20% of a property's value in the area of better water condition, and \$24,000, or 9% of property value, in the area of poorer water condition. The difference is \$41,000, or 11% of property value. (Mertz-PTT)
W90-04963

CADMIUM LEVELS IN OYSTERCATCHER HAEMATOPUS OSTRALEGUS FROM THE GERMAN WADDEEN SEA.

Osnabrueck Univ. (Germany, F.R.). Dept. of Ethology.
For primary bibliographic entry see Field 5B.
W90-04978

CONDITION OF CORAL REEF CNIDARIANS FROM THE NORTHERN FLORIDA REEF TRACT: PESTICIDES, HEAVY METALS, AND HISTOPATHOLOGICAL EXAMINATION.

Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Biology and Living Resources.
For primary bibliographic entry see Field 5B.
W90-04987

RESEARCH INTO HEALTH RISKS AT BATHING BEACHES IN HONG KONG.

R. Holmes.
Journal of the Institution of Water and Environmental Management JIWMMEZ, Vol. 3, No. 5, p 488-495, October 1989. 2 tab, 6 ref.

Descriptors: *Swimming, *Water pollution effects, *Public health, *Beaches, *Hong Kong, Escherichia coli, Staphylococcus, Bioindicators, Water pollution control, Epidemiology, Water quality, Coliforms, Human diseases, Water quality standards, Risk assessment.

The standard measurement of water pollution of bathing beaches in Hong Kong relies on tests for the level of Escherichia coli in water samples. Until recently no reliable data were available on the relationship between pollution levels as measured by this indicator bacteria and the actual level of risk to swimmers. An epidemiological study was undertaken to determine the risks to swimmers using Hong Kong bathing beaches with various levels of pollution by fecal coliforms. Interviews of beach visitors were conducted on the weekends in the summer of 1987 with follow-up telephone calls during the week. Nine beaches were surveyed, representing a range of pollution conditions. Of the 24,308 people interviewed, 18,986 usable responses were obtained. Of these, 78% were swimmers. Symptoms rates were grouped into categories and the number of respondents showing symptoms in each category was tabulated. Results showed that there were higher rates of minor ailments among swimmers than among non-swimming control groups, and that the excess illness rates were pollution-related for most symptom categories, except eye symptoms. The best indicators of health risk due to pollution were found to be E. coli and staphylococci. The existing limit of acceptability applied in Hong Kong corresponds to a risk of 15 skin and gastrointestinal cases per thousand swimmers, a reasonably low rate but still a significant public health problem when multiplied by the very large number of swimmers using the beaches in Hong Kong every year. (Geiger-PTT)
W90-05016

EFFECTS OF A TIMBER PRESERVATIVE SPILLAGE ON THE ECOLOGY OF THE RIVER LOSSIE.

North East River Purification Board, Aberdeen (Scotland).
A. McNeill.

Journal of the Institution of Water and Environmental Management JIWMMEZ, Vol. 3, No. 5, p 496-504, October 1989. 7 fig, 4 tab, 11 ref.

Descriptors: *Stream biota, *Pesticides, *Wood preservatives, *Water pollution effects, *Ecologi-

cal effects, Invertebrates, Rivers, Species diversity, Species composition, Monitoring, Outfall sewers, Fish, Benthos, Mollusks, Crustaceans, Dieldrin, Pentachlorophenol, Organotin compounds.

The effects of sawmill timber preservative spills on the ecology of the River Lossie during recovery of the water quality following removal of an outdated outfall sewer was studied. Biological and chemical parameters were monitored several times a year from 1976-1981 at several sites on the river Lossie upstream and downstream from the city of Elgin where the outfall sewer had been located and on Tyock Burn where the sawmill was located. Invertebrates were retrieved from riffles by kick/hand-net sampling and identified as far as possible. Biological results were presented as biological monitoring working party (BMWP) scores which classified taxon on a scale of 0-10 representing best to worst conditions. Water chemistry was done on 9 parameters and a chemical classification was carried out using the modified water quality index on a scale of 0-100, the former representing worst conditions, and the latter good conditions. Prior to the closing of the outfall sewer in February 1982, stations upstream of the outfall exhibited better water quality than those downstream. After the closing of the outfall the water quality at the stations downstream steadily improved until the preservative spillage in 1983 when the BMWP scores of the stations downstream of Tyock Burn decreased. Invertebrate diversity of these downstream stations remained significantly inhibited until late 1986. High concentrations of dieldrin were detected at stations downstream of the sawmill on Tyock Burn which decreased during the successive years after the preservative spillage until the Burn was dredged in 1985. High levels of dieldrin after the second dredging in 1987 reflected the high levels of the pesticide accumulated in sediments. Continual leaching from the sub-soil of pentachlorophenol, dieldrin, and bis(tributyltin) oxide residues maintained concentrations in the stream at levels which were harmful to fish and lethal to stoneflies. Concentrations of pentachlorophenol in the Tyock Burn were in excess of chronic toxicity levels to many aquatic organisms. (Geiger-PTT)
W90-05017

ACTIVATION OF THE K-RAS ONCOGENE IN LIVER TUMORS OF HUDSON RIVER.

New York Univ. Medical Center, NY. Inst. of Environmental Medicine.
I. Wirgin, D. Currie, and S. J. Garte.
Carcinogenesis CRNGDP, Vol. 10, No. 12, p 2311-2315, December 1989. 1 fig, 2 tab, 55 ref.
NIHES Center Grant 00260, NIH Grant BSRG SO7 RR5399-27, Division of Research Resources and NIH Grant ES 05003.

Descriptors: *Fish physiology, *Water pollution effects, *Hudson River, *Cancer, Tissues, Tomcod, Tumors, Genetics, Comparison studies, Bioassay.

Adult Atlantic tomcod collected from the Hudson River slightly north of New York City have an extremely high incidence (55-90%) of histologically defined hepatocellular carcinomas, whereas tomcod from control sites in Maine or Rhode Island exhibit little evidence of this condition. Genomic DNA was isolated from Hudson tomcod tumors and from normal Hudson and Saco River, Maine tomcod livers and tested for transforming activity in the NIH3T3 transfection assay. Six out of nine tumors (66%) tested proved positive. Southern blot analysis of all primary (6/6) transfectant and nude mouse tumor DNAs revealed evidence of an exogenous tomcod K-ras gene, while no activation of the H-ras gene was observed. These studies demonstrate that an outbred population of fishes and inbred mammals suffer genetic alterations at the same oncogene loci and suggest that similar pathways to neoplasia may be operative in both systems. Oncogene activation in naturally exposed feral populations may prove a particularly sensitive marker of environmental degradation in aquatic systems. (Author's abstract)
W90-05040

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects Of Pollution

WATERSHED ACIDIFICATION MODELS USING THE KNOWLEDGE-BASED SYSTEMS APPROACH

National Water Research Inst., Burlington (Ontario).
D. C. L. Lam, D. A. Swayne, J. Storey, and A. S. Fraser.
Ecological Modelling ECMODT, Vol. 47, No. 1/2, p. 131-152, September 1, 1989. 8 fig, 1 tab, 23 ref.

Descriptors: *Acid rain, *Acid lakes, *Watersheds, *Model studies, Canada, Sulfur dioxide, Water chemistry, Data processing, Data interpretation.

A novel approach to prediction of lake acidification is presented. The Cation Denudation Rate (CDR) and the Trickle Down (TD) Acidification Models are used for illustration. Instead of selecting one model and discarding the other, each model is utilized in those cases where it is most applicable, an approach which requires both a quantitative and qualitative judgement or rules to choose the proper model. This model has been implemented in a workstation environment—RAISON Micro—which has been designed to facilitate automated model selection and analysis. The results of a preliminary test using the water chemistry data from 53 southern Quebec watersheds in Canada with 364 sampling stations are presented. Statistical comparison with observed data was found to be more favorable than that for the individual models. The results are improved by the system's built-in facility to correct anomalous behavior in circumstances for which an incorrect model choice has been made in the absence of definitive knowledge. The uncertainties of the individual models and the combined model were found to be greater for higher SO₂ inputs but became smaller for reduced loads. (Author's abstract) W90-05043

ASSESSMENT IN RATS OF THE GONADOTOXIC AND HEPATORENAL TOXIC POTENTIAL OF DIBROMOCHLOROPROPANE (DBCP) IN DRINKING WATER

National Toxicology Program, Research Triangle Park, NC.
For primary bibliographic entry see Field 5F.
W90-05046

PERCH, PERCA FLUVIATILIS L., IN SMALL LAKES: RELATIONS BETWEEN POPULATION CHARACTERISTICS AND LAKE ACIDITY

Helsinki Univ., Lammi (Finland). Lammi Biological Station.
M. Rask.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 74, No. 2, p. 169-178, 1989. 4 fig, 6 tab, 38 ref.

Descriptors: *Water pollution effects, *Acid lakes, *Acid rain effects, *Fish populations, *Aluminum, Hydrogen ion concentration, Humic lakes, Biomass, Population density, Perch.

Perch population characteristics of small lakes were examined with a special reference to lakes which have acidified recently due to atmospheric deposition of air pollutants. The population density and biomass of perch were higher in an acid (pH 4.5) clear water lake with low aluminum concentration than in recently acidified (pH 4.3-4.7) clear water lakes with higher aluminum levels. The structure of perch population in an acid (pH 4.4) humic lake was similar to recently acidified clear water lakes. The population density and the biomass of perch were significantly higher in 6 lakes with pH > 5.0 than in 6 lakes of pH < 5.0 whereas the mean age and length at a given age were higher in the more acid lakes. (Author's abstract) W90-05048

TEMPORAL VARIATIONS OF THE ULTRASTRUCTURE IN SCENEDESMUS QUADRICAUDA EXPOSED TO COPPER IN A LONG TERM EXPERIMENT (VARIATIONS TEMPORELLES DE L'ULTRASTRUCTURE DE SCENEDESMUS QUADRICAUDA EXPOSEE AU CUIVRE LORS D'UNE EXPERIENCE A LONG TERME)

Quebec Univ., Chicoutimi. Dept. des Sciences Fondamentales.
C. Bastien, and R. Corte.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 74, No. 2, p. 207-219, 1989. 13 fig, 29 ref. English summary.

Descriptors: *Bioassay, *Copper, *Water pollution effects, *Heavy metals, *Chlorophyta, Scenedesmus, Physiology, Cell structure, Spectral analysis, Tolerance.

An experiment was conducted with a continuous culture of Scenedesmus quadricauda for 50 days in a copper concentration of 250 micrograms/L. Ultrastructural examinations were carried out at different times to obtain the sequence of events. After 1.5 h of exposure, the ultrastructural effects were obvious: the chloroplasts were retracted and all cell structures appeared diffuse. The same observations were reported after 3, 6, 12 and 24 hours. Between the 3rd and 15th days of the experiment, the cells showed major accumulations of starch, lipid and electron-dense inclusions in the vacuoles, and the cell walls became thicker. After 22, 32 and 50 days the cells appeared normal, but the cytoplasm was densely packed with ribosomes and the endoplasmic reticulum was evident in most cells. However, atomic absorption analysis for copper showed that there was no bioaccumulation after 50 days of exposure. These findings suggest the implication of a second tolerance mechanism to copper (possibly extracellular complexation or removal) that is activated after long exposure, in contrast to electron-dense inclusions, which appear after a relatively short time (2 days). (Author's abstract) W90-05050

STUDIES ON THE EFFECT OF CELL DIVISION-INHIBITING HERBICIDES ON UNIALGAL AND MIXED ALGAL CULTURES

Keszthely Agricultural Univ., Mosonmagyaróvár (Hungary). Inst. of Crop Production.
V. Ordog, and K. Kuivasniemi.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 74, No. 2, p. 221-226, 1989. 4 fig, 2 tab, 19 ref.

Descriptors: *Bioindicators, *Bioassay, *Herbicides, *Algae, *Chlorophyta, Scenedesmus, Oocystis, Selenastrum, Toxicity, Growth, Oxygen production, Trifluralin, Diphenamid.

The effect of two cell division inhibiting herbicides on unialgal and mixed algal cultures was studied in laboratory tests. The herbicides studied were trifluralin (analytical grade) and the active ingredient as well as the preparation (80% a.i.) of diphenamid. The three green algal species used were Selenastrum capricornutum Printz, Scenedesmus quadricauda (Turp.) Breb., Oocystis parva W. et G. S. West. The response of algae to herbicides was determined by cell counting, and measured by turbidity (750 nm) and the O₂-production of some of the treated cultures. The EC₅₀-value (96 h) of trifluralin to Selenastrum capricornutum was 3.3 micrograms/L. There were differences in the sensitivity of the three algal strains to the diphenamid; the EC₅₀-values to Selenastrum, Scenedesmus and Oocystis were 16.7, 10.1 and 6.3 micrograms/L, respectively. The lag phase observed in the growth of the treated cultures caused by diphenamid was verified by O₂-measurements. The preparation of diphenamid was not as effective as the active ingredient. In mixed cultures the ratio between two different algal strains depended both on the concentration of the diphenamid and the sensitivity of the two strains. (Author's abstract) W90-05051

NUMERICAL WATER ASSESSMENT OF RIVERS IN HOKURIKU DISTRICT USING EPILITHIC DIATOM ASSEMBLAGE ON RIVER BED AS A BIOLOGICAL INDICATOR. (III) SEASONAL CHANGES OF THE DIATOM ASSEMBLAGE INDEX TO ORGANIC WATER POLLUTION (DAI(PO)) AND RIVER POLLUTION INDEX (RPI(D)), (IN JAPANESE).

M. Sumita.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p. 199-205, 1989. 2 fig, 2 tab, 10 ref. English

summary.

Descriptors: *Bioindicators, *Japan, *Water pollution effects, *Diatoms, Pollution index, Seasonal variation, Nonpoint pollution sources.

The seasonal changes of the DAI(po) value (Diatom Assemblage Index to organic water pollution) and RPI(D) (River Pollution Index) in summer (from 1 June to 31 August) and winter (from 1 November to 28 February) of rivers in the Hokuriku District were investigated. The averages were calculated and histogram were constructed from the DAI(po) values for 112 stations in four river basins. From these data, the following results were obtained. There was no obvious difference in the average of DAI(po) for all investigated stations between seasons. But in the Todorigawa River Basin and the rivers in the Noto Peninsula, DAI(po) values had a tendency to be higher in winter than in summer, while those in the Kakehashi River Basin and the Iburibashi River Basin showed reverse tendency. In the River Todorigawa RPI(D) values were higher in winter than in summer. In the downstream portion of the River Kakehashi-gawa and its tributary (canal), RPI(D) values were higher in winter or almost equal between two seasons. Increase of the river discharge by snow-melt and the pollution load imposed by agriculture should be considered important factors controlling the seasonal changes of the water quality in the rivers of Hokuriku District. (Author's abstract) W90-05052

U.S. GEOLOGICAL SURVEY TOXIC SUBSTANCES HYDROLOGY PROGRAM: PROCEEDINGS OF THE TECHNICAL MEETING, PHOENIX, ARIZONA, SEPTEMBER 26-30, 1988

For primary bibliographic entry see Field 5B.
W90-05059

SILICA MOBILITY IN A PETROLEUM-CONTAMINATED AQUIFER

Texas Univ. at Austin. Dept. of Geological Sciences.
P. Bennett.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988, USGS Water-Resources Investigations Report 88-4220, 1989. p. 5-11, 5 fig, 12 ref.

Descriptors: *Water pollution effects, *Weathering, *Groundwater pollution, *Aquifers, *Oil pollution, *Silica, *Minnesota, Hydrogen ion concentration, Quartz, Iron, Precipitation, Solubility.

Sediments and water from a petroleum-contaminated aquifer near Bemidji, Minnesota, were examined to determine the effects of dissolved organic compounds on silica mobility. The results of this study indicate that the dissolution of quartz and aluminosilicate minerals is accelerated in the zone with the highest concentration of dissolved organic carbon, as shown by an increase in dissolved-silica concentration from 18 mg/L to greater than 20 mg/L, indicating an apparent increase in the solubility of quartz. Microscopic evidence of rapid weathering of quartz can be seen where dissolved silica is highest. The interaction occurs at neutral pH and is most apparent where the redox potential is lowest. Downgradient from the zone of dissolution, silica rapidly precipitates from solution as both amorphous silica and authigenic quartz. The zone of precipitation coincides with an increase in groundwater redox potential, and is accompanied by the precipitation of iron. Laboratory dissolution experiments and spectroscopic investigations suggest that silica is being complexed by multifunctional organic acids. This increases the solubility and rate of dissolution of quartz and aluminosilicates at neutral pH, conditions in which aluminum complexation is insignificant. The interaction of silica and organic acids at the Bemidji site may be analogous to processes associated with organic-rich environments of geologic and economic importance. (See also W90-05059) (Author's abstract) W90-05060

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: I. THE DISTRIBUTION OF CHEMICAL SPECIES AND GEOCHEMICAL FACIES.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05061

FATE AND EFFECTS OF CRUDE OIL IN A SHALLOW AQUIFER: II. EVIDENCE OF ANAEROBIC DEGRADATION OF MONOAROMATIC HYDROCARBONS.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W90-05062

PRELIMINARY ASSESSMENT OF THE EFFECTS OF ACID MINE DRAINAGE ON GROUND WATER BENEATH A WETLAND NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05072

UPTAKE OF MANMADE ORGANIC COMPOUNDS BY RANGIA CUNEATA IN THE LOWER CALCASIEU RIVER, LOUISIANA.

Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W90-05094

STATUS REPORT ON A STUDY OF THE EFFECTS OF ACID MINE DRAINAGE ON VEGETATION NEAR LEADVILLE, COLORADO.

Geological Survey, Denver, CO.
B. M. Erickson.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p649-651, 1 fig.

Descriptors: *Water pollution effects, *Acid mine drainage, *Colorado, *Vegetation, *Wetlands, Sampling, Seasonal variation, Heavy metals.

Moss, grass and soil samples were collected from eight sites along St. Kevin's Gulch, Leadville, Colorado. Samples of sedge, horsetail, and cow manure also were collected where present. The sampling sites were located from about the area of mine drainage downstream to where St. Kevin enters a wetland. All samples have been prepared and submitted to the Branch of Geochemistry Laboratories for inductively coupled plasma-atomic emission spectroscopy (40 elements) and atomic absorption (As, Hg, Sb, and Se) analyses. Field work in 1988 will concentrate on the wetland—determining the major ecotypes, establishing permanent sampling plots, and beginning the sampling on a seasonal basis. Vegetative sampling also will be conducted in conjunction with peat sampling to define metal flux in the wetland ecosystem. (See also W90-05059) (Author's abstract)
W90-05128

ASSESSMENT OF POTENTIAL TOXIC PROBLEMS IN NON-URBAN AREAS OF PUGET SOUND.

Tetra Tech, Inc., Bellevue, WA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134332. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA 503/3-88-002, August 1988. Final Report. 173p, 14 fig, 37 tab, 76 ref. EPA Contract Nos. 68-03-3319 and 68-02-4341.

Descriptors: *Environmental effects, *Bays, *Toxicity, *Puget Sound, *Water pollution sources, *Water pollution effects, Guemes/Fidalgo Channel, Port Angeles Harbor, Crescent Harbor, Richmond Beach, Liberty Bay, Biological studies.

Information was compiled on potential environmental degradation from toxic chemical contaminants in nonurban areas within Puget Sound. The objectives of the study are: (1) to identify, by interpreting existing information, nonurban areas in

Puget Sound that may have serious contamination or biological problems; and (2) to prioritize those areas for future detailed studies. The information in this report is grouped according to the 12 regions of Puget Sound used in the Puget Sound Environmental Atlas. For each embayment, three categories of information were gathered—known and suspected sources of toxic substances, the results of sediment chemistry analyses, and information on local toxicity problems. Information on possible sources of toxic substances is included in this report to determine whether contamination might be expected to exist in an area. These sources included permitted industrial and municipal discharges and hazardous waste sites. This information was used to evaluate sites that had not been sampled. Four types of biological indexes are used in this report to measure the extent of environmental degradation: bioassays, bioaccumulation, fish histopathological abnormalities, and fishkill information. Because of the lack of a substantial database, several other indices of biological impacts were excluded from the report. Fishkills known to have been caused by low dissolved oxygen concentrations were excluded from the report. Of the 97 nonurban areas of Puget Sound evaluated in this study by the Environmental Assessment Matrix technique, only 6 received a ranking of HIGH which may qualify them for consideration as sites for future, detailed investigations. The areas of significant concern are: the Guemes/Fidalgo Channel (Region 2), Port Angeles Harbor (Region 3), Crescent Harbor (Region 2), Richmond Beach (Region 8), Liberty Bay (Region 9), and East Passage (Region 11). Forty-two other areas received a MEDIUM ranking. As might be expected, industrialized regions contained the larger numbers of MEDIUM sites. The results can be grouped according to the number of MEDIUMs within each region as follows: Regions 3 and 7 each had 1, Regions 2,5,6, and 10 had 2, Region 1 had 3, Region 4 and 11 each had 4, Region 12 had 5, Region 8 had 6, and Region 9 had 10. All other sites were ranked low. (Lantz-PTT)
W90-05129

EVALUATION OF THE AQUATIC TOXICITY AND FATE OF BRASS DUST USING THE STANDARD AQUATIC MICROCOSM.

Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD.
W. G. Landis, N. A. Chester, M. V. Haley, D. W. Johnson, and W. T. Muse.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 271. Price codes: A03 in paper copy, A01 in microfiche. Report No. CRDEC-TR-88116, July 1988. 24p, 8 fig, 18 ref.

Descriptors: *Path of pollutants, *Toxicity, *Water pollution effects, *Aquatic environment, *Brass, Copper, Zinc, Heavy metals, Ecological effects, Fate of pollutants, Standard aquatic microcosm.

The impact of brass dust on a model aquatic ecosystem, the Standard Aquatic Microcosm (SAM), was investigated. The SAM appeared to be capable of exhibiting a variety of effects due to the application of the toxicant. The brass-SAM demonstrated the differential toxicity of the toxicant to the daphnid population and algae. The proportional increase in biomass of the algae to the concentration of the toxicant was a direct outcome of the differential toxicity. During sampling, resuspension of the brass also made the toxicant repeatedly available to the filter feeding organisms; but, in temperate lakes, the fall and spring turnovers mix bottom material with the water column. Nutrient cycling in the brass-SAM also demonstrated stress in a dose-response manner. The nitrogen and phosphate cycling were clear examples. In evaluating toxic effects, individual criteria such as species diversity, biomass P/R ratio, and nutrient cycling cannot be used individually to identify an impact. In the brass microcosm, only the highest concentration demonstrated a decrease in algal diversity and then only after the halfway point of the experiment. Although the 0.5 mg/L concentration demonstrated effects in algal and daphnid growth attributable to the brass, no significant decrease in the algal diversity was apparent. Fate of the toxicant can be

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followed; the results mimic those of a natural ecosystem as opposed to a laboratory abiotic experiment. In laboratory experiments using waters of varying hardness, the brass dissociated into copper and zinc. The dissociation occurred whether the material was placed on the surface of the water or sonicated into suspension. The concentrations of these materials increased over time. Although there are limitations to the ability of the SAM to mimic full-scale ecosystems, a brass concentration as low as 0.5 mg/L had long-term effects. (Lantz-PTT)
W90-05143

SYNTHESIS OF RESEARCH RESULTS: APPLICABILITY AND FIELD VERIFICATION OF PREDICTIVE METHODOLOGIES FOR AQUATIC DREDGED MATERIAL DISPOSAL.

Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5E.
W90-05145

GROUNDWATER HEALTH RISK ASSESSMENT: A CASE STUDY.

California Univ., Los Angeles. Dept. of Environmental Science and Engineering.
D. A. Bailey, P. F. Ricci, and G. Whelan.
IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 129-147, 5 fig, 3 tab, 33 ref.

Descriptors: *Public health, *Risk assessment, *Groundwater pollution, *Path of pollutants, *Model studies, Water pollution effects, Selenium, Fate of pollutants, Case studies.

The risk-cost-benefit (RCB) methodology can be used to address the impact of leachates from waste facilities associated with coal-fired powerplants. A case study demonstrates the use of the methodology at a hypothetical plant at a non-arid midwestern site. Level I and Level II assessments analyzed the movement of selenium from a combined ash pond and landfill through the groundwater pathway. The numerical code PRZM (Pesticide Root Zone Model) and the analytical code RAPCON (Rapid Assessment Contaminant Transport Model) simulated selenium movement in the unsaturated zone. Modeling of solute transport was performed only in the mini-region with the CFEST (Coupled Fluid, Energy, and Solute Transport) code. The groundwater modeling depicted variations in the mobility of selenium and in the Level I and Level II assessments. These simulations also predicted selenium concentrations at a nearby pumping well. The concentrations were used as an indication of lifetime human exposure levels for individuals drinking water from the well. The Level II analysis, which refines the Level I modeling, indicated that adverse health effects would not be expected because the daily exposure through drinking water would be < 35 micrograms/L. (See also W90-05169) (Lantz-PTT)
W90-05179

EFFECTS OF AGRICULTURAL PRACTICES AND SEPTIC-SYSTEM EFFLUENT ON THE QUALITY OF WATER IN THE UNCONFINED AQUIFER IN PARTS OF EASTERN SUSSEX COUNTY, DELAWARE.

Delaware Geological Survey, Newark.
For primary bibliographic entry see Field 4C.
W90-05209

RESULTS OF HYDROLOGIC RESEARCH AT A LOW-LEVEL RADIOACTIVE-WASTE DISPOSAL SITE NEAR SHEFFIELD, ILLINOIS.

Geological Survey, Champaign, IL. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-05221

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects Of Pollution

ASSESSMENT OF PROCESSES AFFECTING LOW-FLOW WATER QUALITY OF CEDAR CREEK, WEST-CENTRAL ILLINOIS.

Geological Survey, Urbana, IL. Water Resources Div.

For primary bibliographic entry see Field 5B. W90-05223

INVENTORY AND EVALUATION OF BIOLOGICAL INVESTIGATIONS THAT RELATE TO STREAM-WATER QUALITY IN THE UPPER ILLINOIS RIVER BASIN OF ILLINOIS, INDIANA, AND WISCONSIN.

Geological Survey, Denver, CO. Water Resources Div.

D. W. Steffek, and R. G. Striegl. Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4041, 1989. 58p, 5 fig, 4 tab, 237 ref.

Descriptors: *Biological studies, *Water quality, *Bioassay, *Illinois River Basin, Water pollution effects, Pollutant identification, Illinois, Indiana, Wisconsin, Fish, Macroinvertebrates.

Results of studies of the aquatic biology of the upper Illinois River basin provide a historical data source from which inferences can be made about changes in the quality of water in the main stem river and its tributaries. The results of biological investigations that have been conducted throughout the basin since 1900 are summarized and their relevance to stream-water-quality assessment is described, particularly their relevance to the upper Illinois River basin pilot project for the National Water Quality Assessment program. Four general categories of biological investigations were identified: Populations and community structure, chemical concentrations in tissue, organism health, and toxicity measurements. Biological investigations were identified by their location in the basin and by their relevance to each general investigation category. The most abundant literature was in the populations and community structure category. Tissue data were limited to polychlorinated biphenyls, organochlorine pesticides, dioxin, and several metals. The most cited measure of organism health was a condition factor for fish that associates body length with weight or body depth. Toxicity measurements included bioassays and the Ames Tests. The bioassays included several testing methods and test organism. (USGS) W90-05224

BIOACCUMULATION OF CINMETHYLIN IN BLUEGILL SUNFISH.

Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Agricultural Products Dept.

P. W. Lee, A. D. Forbis, and L. Franklin. Journal of Agricultural and Food Chemistry JAFCAU, Vol. 38, No. 1, p 323-327, January 1990. 3 fig, 5 tab, 5 ref.

Descriptors: *Herbicides, *Bioaccumulation, *Cinmethylin, *Sunfish, *Path of pollutants, *Biological magnification, *Pesticide residues, Degradation products, Biotransformation, Bioassay, Carbon radioisotopes, Radiochemical analysis, Tissue analysis, Animal pathology, Path of pollutants, Metabolism.

Cinmethylin (7-oxabicyclo(2.2.1)heptane, 1-methyl-4-(1-methylethyl)-2-(2-methylphenyl)methoxy-, exo-) is the active ingredient of Cinch 7EC herbicide. In order to assess its potential impact to the environment, the bioaccumulation potential of cinmethylin in the bluegill sunfish was examined. Technical cinmethylin and Cinch 7EC herbicide showed low toxicity against various aquatic organisms. The bioaccumulation potential of (14)C-cinmethylin in the bluegill sunfish under a dynamic flow-through system at a constant concentration of 0.1 mg/L was examined. A rapid uptake of radioactivity was observed. Tissue residues plateaued after 3 days, and the mean tissue residues after 28 days of exposure were 35, 12, and 58 microg/g (ppm) for the whole fish, fillet, and viscera, respectively. The corresponding bioconcentration factors for the above tissues were 360, 120, and 600, respectively. Greater than 99%

of the tissue residues were eliminated from the exposed fish after the 14-day depuration period. In addition to (14)C-cinmethylin, major metabolites isolated from the treated fish were alpha-carboxycinmethylin and 8-hydroxy-alpha-carboxycinmethylin. Ortho-toluic acid and alpha-hydroxycinmethylin were observed as minor components. (Author's abstract) W90-05327

STUDIES ON THE MACRO-BENTHIC ORGANISMS ABOVE AND BELOW THE TAYLOR RUN DOMESTIC SEWAGE DISPOSAL PLANT, WEST CHESTER, PENNSYLVANIA, 1968-1986.

W. R. Overlease. Journal of the Pennsylvania Academy of Science, Vol. 63, No. 2, p 122-126, 1989. 1 tab.

Descriptors: *Wastewater disposal, *Water pollution effects, *Aquatic insects, *Benthic fauna, *Effluent streams, Aquatic animals, Pennsylvania.

Macro-benthic organisms were monitored for nineteen years (1968-1986) on Taylor Run above and below the domestic sewage disposal plant. Sampling was done twice a year in early spring and fall. A table summarizing the data for 34 taxa is presented. Tubificids, sowbugs, and midge larva populations increased considerably from 1973 to 1986 when sewage overload of the Taylor Run Domestic Sewage Plant occurred. Decreases in caddisfly larva and mayfly nymphs also became apparent below the plant during this period. Long-term increases in fishy larva, broad-shouldered water strider and caddisfly larva populations above the plant were observed between 1974 and 1986. Flatworm populations increased above the plant beginning 1977 and whirligig beetles completely disappeared as of 1970. The building of a new disposal plant coincided with an increase in blackfly larva populations below the plant in 1983, suggesting changes in organic particulate matter in the effluent. The macro-benthic life above the plant was wiped out the summer of 1986, just after this study was completed. (Male-PTT) W90-05336

GENUS ISOETES IN SCANDINAVIA: AN ECOLOGICAL REVIEW AND PERSPECTIVES.

Norsk Inst. for Vannforskning, Oslo.

B. Rorslett, and P. Brettum. Aquatic Botany AQBODS, Vol. 35, No. 3-4, p 223-261, November 1989. 9 fig, 2 tab, 198 ref.

Descriptors: *Macrophytes, *Acid rain effects, *Water pollution effects, *Aquatic plants, *Acidic water, Stress analysis, Eutrophication, Water level fluctuations, Aquatic habitats, Scandinavia, Quillwort.

Information relating to the Scandinavian quillwort species, *Isoetes lacustris* L. and *I. setacea* Lam. (Syn. *I. echinospora* Durieu), is reviewed emphasizing their ecological adaption to infertile and shaded habitats, where stress results from inadequate levels of light, available carbon and nutrients. In addition, their habitats can feature enhanced disturbance and stress arising from man-made and natural impacts such as acidification, eutrophication, water-level alteration, ice scour, and sediment instability. Quillworts have evolved a variety of mechanisms by which these adverse impacts can be mitigated. Such adaptations comprise carbon acquisition through crassulacean acid metabolism (CAM), high root biomass, slow turnover, resource reallocation on the vertical gradient of their habitat and other related features typical for an S-strategist (Stress tolerator). However, the success of this strategy is by no means guaranteed. In fact, the quillworts are ultimately victims of their own, insufficiently flexible, growth strategy under sustained adverse environmental impacts. Evidently *I. setacea* fares better than *I. lacustris* in this respect. It is suggested that research into the extent and rate of vegetation changes driven by acidification should be further advanced, since contradictory evidence seems to exist on this issue. (Author's abstract) W90-05338

HABITAT CONDITIONS OF THE PHYTOCOENOSES OF MYRIOPHYLLETUM ALTER-NIFLORI LEMEE 1937 EM. SISS. 1943, MYRIOPHYLLETUM VERTICILLATI SOO 1927 AND MYRIOPHYLLETUM SPICATI SOO 1927 IN POLAND.

Warsaw Univ. (Poland). Dept. of Phytogeography.

For primary bibliographic entry see Field 2H. W90-05339

TWO MANIPULATED INNER BAYS IN THE HELSINKI SEA AREA, NORTHERN GULF OF FINLAND.

Helsinki City Water and Wastewater Authority (Finland). Water Conservation Lab.

For primary bibliographic entry see Field 5G. W90-05346

MICROHABITAT AVAILABILITY IN WELSH MOORLAND AND FOREST STREAMS AS A DETERMINANT OF MACROINVERTEBRATE DISTRIBUTION.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.

For primary bibliographic entry see Field 2H. W90-05360

DEVELOPING A STATISTICAL SUPPORT SYSTEM FOR ENVIRONMENTAL HAZARD EVALUATION.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.

J. Cairns, and E. P. Smith. Hydrobiologia HYDRB8, Vol. 184, No. 3, p 143-151, November 8, 1989. 34 ref.

Descriptors: *Risk assessment, *Bioassay, *Statistical models, *Toxicity, Statistical analysis, Hazardous materials, Testing procedures, Public health.

Estimating the hazard or risk to both human health and the environment has been based almost exclusively on single species toxicity tests low in environmental realism and without validation of their accuracy in more complex systems. While this may be quite appropriate for humans in a large variety of circumstances, there is no substantive body of direct experimental evidence indicating that precise predictions of harm from hazardous materials can be extrapolated from single species laboratory tests (or even multispecies laboratory tests) to the more complex highly variable natural systems. Now added to the hazardous chemical assessment problem is the accidental or deliberate release of genetically engineered microorganisms into the environment that will have the additional capability of multiplying and expanding their numbers and also transferring genetic information to other organisms. This paper focuses entirely on hazard evaluation for organisms other than humans, namely predicting the potential risk or probability of harm to natural systems based on laboratory toxicity testing using single species. In addition to examining the basic risk assessment strategy itself, the question of determining the statistical reliability of various extrapolations from one level of biological organization to another is analyzed. (Author's abstract) W90-05369

CANOCO—AN EXTENSION OF DECORANA TO ANALYZE SPECIES-ENVIRONMENT RELATIONSHIPS.

Instituut TNO voor Wiskunde, Informatieverwerking en Statistiek, Wageningen (Netherlands). Agricultural Mathematics Group.

C. J. F. ter Braak. Hydrobiologia HYDRB8, Vol. 184, No. 3, p 169-170, November 8, 1989. 14 ref.

Descriptors: *Data interpretation, *Data processing, *Statistical methods, *Canonical ordination, *Canonical correspondence analysis, CANOCO, Statistical models, Species diversity, Computer models, Water pollution effects.

Effects Of Pollution—Group 5C

A common problem in community ecology and ecotoxicology is to discover how a multitude of species respond to external factors such as environmental variables, pollutants and management regime. Data are collected on species composition and the external variables at a number of points in space and time. To analyze such data, presently available statistical methods either assumed linear relationships or were restricted to regression analysis of the response of each species separately. To analyze the generally non-linear, non-monotone response of a community of species, one had to resort to the data-analytic methods of ordination and cluster-analysis 'indirect methods' that are generally less powerful than the 'direct' statistical method of regression analysis. Recently, regression and ordination have been integrated into techniques of multivariate direct gradient analysis, called canonical ordination (Jongman et al., 1987; ter Braak & Prentice, 1988). The use of canonical ordination greatly improves the power to detect the specific effects in which one is interested. One of these techniques, canonical correspondence analysis, escapes the assumption of linearity and is able to detect unimodal relationships between species and external variables (ter Braak, 1986, 1987a). The computer program CANOCO is designed to make these techniques available to ecologists studying community responses. (Author's abstract) W90-05370

ALGAL EPILITHON AND WATER QUALITY OF A STREAM RECEIVING OIL REFINERY EFFLUENT.

North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
A. K. Singh, and J. P. Guar.
Hydrobiologia HYDRB8, Vol. 184, No. 3, p 193-199, November 8, 1989. 1 fig, 5 tab, 24 ref.

Descriptors: *Water pollution effects, *Periphyton, *Effluent streams, *Oil pollution, *Algae, Algal growth, India, Species diversity, Cyanophyta, Biomass, Monitoring.

Changes in epilithic algal communities colonizing introduced substrata were determined in a stream polluted with oil refinery effluent at Digboi (Assam, India). The number of algal taxa was reduced but the growth of blue-green algae, particularly two species of Oscillatoria, was encouraged. Epilithic biomass (as chlorophyll-a) also declined at polluted stations. The algal community of the upstream station was markedly different from the community occurring just after the confluence of the effluent; however, the differences were gradually reduced downstream, indicating improvement in water quality. Species richness, Shannon diversity, and biomass criteria showed significant relationships with the level of pollutants. This study demonstrates the usefulness of algal criteria for monitoring oil pollution in running waters. (Author's abstract) W90-05372

GROWTH INHIBITION BY HIGH LIGHT INTENSITIES IN ALGAE FROM LAKES UNDERGOING ACIDIFICATION.

University of Western Ontario, London. Dept. of Plant Sciences.
K. O'Grady, and L. M. Brown.
Hydrobiologia HYDRB8, Vol. 184, No. 3, p 201-208, November 8, 1989. 5 fig, 1 tab, 22 ref. Ontario Ministry of the Environment.

Descriptors: *Acid rain effects, *Algal blooms, *Acidic water, *Algae, *Light intensity, Acid lakes, Chlorophyta, Hydrogen ion concentration, Nitrogen, Vertical distribution, Algal growth.

Blooms of *Chrysochromulina brevitririta* Nich. (Prymnesiophyceae) have been found to be restricted to lakes above pH 5.5 even though the alga is able to tolerate pH 4.0 in laboratory culture. A possible explanation is the increased transparency in acidifying lakes and a sensitivity of *C. brevitririta* to high light intensities. A comparison was made with *Mougeotia* sp., a filamentous green alga which co-occurs in moderately acidic lakes and has a similar pH tolerance range. This alga forms dense, floating mats or amorphous clouds in the

upper littoral zone, where it would be exposed to full sunlight irradiances. In cultures of *C. brevitririta*, prolonged exposures to 1600 microE/sq m/s (10⁶) resulted in reductions in cell yield which were age-dependent at the onset of exposure to high light intensity. Only cultures exposed to high light intensities during late stationary phase were able to recover to control levels and no recovery occurred if these cultures were nitrogen deficient. *Mougeotia* was more tolerant of both high light intensity and nitrogen limitation during the recovery period. The inability of *C. brevitririta* to recover from the effects of high light intensity during nitrogen deprivation may be particularly important in small, stratified lakes which are undergoing acidification. The slow rate of vertical circulation and increasing transparency would prolong exposure of the alga to the high irradiance levels of nutrient deficient epilimnetic waters. This suggests that the geographic distribution of *C. brevitririta* may be explained in part by the increasing light intensities in lakes undergoing acidification. (Author's abstract) W90-05373

SHORT-TERM THERMAL EFFECTS OF A POWER-GENERATING PLANT ON ZOOPLANKTON IN THE SWARTKOP ESTUARY, SOUTH AFRICA.

Port Elizabeth Univ. (South Africa). Dept. of Zoology.
R. Perissinotto, and T. Wooldridge.
PSZNI: Marine Ecology MAECDR, Vol. 10, No. 3, p 205-219, 1989. 3 fig, 3 tab, 46 ref.

Descriptors: *South Africa, *Thermal pollution, *Plankton, Chlorination, Estuaries, Thermal stress, Synergistic effects.

The short-term effect of elevated water temperatures (change in temperature is equal to 5-10°C after passing through the cooling circuit of an electricity generating plant) on plankton in a warm temperature estuary, South Africa, was investigated. Phytoplankton entrained on the flood tide was more severely affected than that entrained on the ebb, but chlorination of cooling water was probably a major factor affecting phytoplankton assemblages. Abundance of zooplankton of marine origin was significantly reduced after passing through the cooling circuit. The effect of thermal stress on the euryhaline zooplankton was not clear, as the origin of the water canal to the generators is located at the extreme seaward limit of spatial distribution of estuarine plankton at low tide. Estuarine species of zooplankton were therefore infrequently sampled and in low numbers only. Both phytoplankton and zooplankton communities may also be subjected to additional stress due to pollutants either associated with the power plant or discharged from other sources. Synergistic effects of toxic substances together with elevated temperatures have been shown to be associated with enhanced mortality rates. (Author's abstract) W90-05377

EFFECTS OF INDUSTRIAL POLLUTION ON THE DEVELOPMENT AND SUCCESSION OF MARINE FOULING COMMUNITIES: I. ANALYSIS OF SPECIES RICHNESS AND FREQUENCY DATA.

Wollongong Univ. (Australia). Dept. of Biology.
P. J. Moran, and T. R. Grant.
PSZNI: Marine Ecology MAECDR, Vol. 10, No. 3, p 231-246, 1989. 2 fig, 5 tab, 38 ref. State Pollution Control Commission of New South Wales.

Descriptors: *Australia, *Water pollution effects, *Species diversity, Fouling, Bays, Species composition, Industrial wastewater, Bioindicators, Data interpretation.

The effects of industrial pollution were determined by comparing the pattern of development of marine fouling communities situated along a pollution gradient within Port Kembla Harbour (Australia) with those from nearby Wollongong Harbour, a relatively unpolluted area. Fifty-three fouling species were found in the communities from Wollongong Harbour compared to only 40 in

those from Port Kembla Harbour. Twenty-eight species (including many bryozoans) occurred only in Wollongong Harbour, while 15 species occurred solely in Port Kembla Harbour. Ten of the 25 species common to both areas were more numerous in Port Kembla Harbour, probably because of the greater availability of free substratum and food in this area. The species richness of fouling communities in Port Kembla Harbour was found to decrease as pollutant concentrations increased. In both study areas, communities established in summer showed significantly higher species richness than those whose development was initiated in winter. This difference was less pronounced in Port Kembla Harbour and was attributed to the effects of pollution on larval settlement. Although species richness increased at all sites through time, Wollongong Harbour communities contained a greater number of species at the end of the experiment than communities from Port Kembla Harbour. Despite this, fewer species of the communities of Wollongong Harbour were found in the very early developmental stages. This result highlights the inherent problems associated with using species richness or diversity measures as a means of determining marine environmental quality. (See also W90-05379) (Author's abstract) W90-05378

EFFECTS OF INDUSTRIAL POLLUTION ON THE DEVELOPMENT AND SUCCESSION OF MARINE FOULING COMMUNITIES: II. MULTIVARIATE ANALYSIS OF SUCCESSION.

Wollongong Univ. (Australia). Dept. of Biology.
P. J. Moran, and T. R. Grant.
PSZNI: Marine Ecology MAECDR, Vol. 10, No. 3, p 247-261, 1989. 2 fig, 4 tab, 39 ref. State Pollution Control Commission of New South Wales.

Descriptors: *Australia, *Water pollution effects, *Species composition, Fouling, Bays, Species diversity, Succession, Multivariate analysis, Data interpretation.

The successional stages of fouling communities from three sites located along a pollution gradient within Port Kembla Harbour (Australia) were compared quantitatively with those from Wollongong Harbour, a relatively unpolluted area located close by. A multivariate classification of the data showed that the development of fouling communities in Port Kembla Harbour was very different from that in Wollongong Harbour, involving different types of species. In addition, the classification identified a secondary pattern in the data which showed that the species composition of the Port Kembla Harbour communities changed with time, independently of any seasonal effects. A principal coordinate analysis of the data was able to expand these findings further. It demonstrated that the succession of fouling communities in Port Kembla Harbour involved a process whereby one group of different species (ascidians) was gradually replaced through time by a second group of different species (bivalves). In contrast, the communities in Wollongong Harbour were dominated by inhibitory interactions. The succession in this area mainly involved species (particularly bryozoans) which colonized during the initial stages of development and remained in the communities as they continued to develop. Changes in the succession of fouling communities from Port Kembla Harbour were thought to be due to the loss of pollution sensitive species, such as bryozoans, from the environment. This was not attributed to the acute, toxic effects of the pollutants, but rather to more subtle and indirect effects. (See also W90-05378) (Author's abstract) W90-05379

ECOLOGY OF TROPICAL SOFT-BOTTOM BENTHOS: A REVIEW WITH EMPHASIS ON EMERGING CONCEPTS.

Australian Inst. of Marine Sciences, Townsville.
For primary bibliographic entry see Field 2L.
W90-05384

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects Of Pollution

EFFECT OF EUTROPHICATION ON SPECIES COMPOSITION AND GROWTH OF FRESH-WATER MUSSELS (MOLLUSCA, UNIONIDAE) IN LAKE HALLWIL (AARGAU, SWITZERLAND).

Institut fuer Pflanzenbiologie, Zurich (Switzerland).

H. E. Arter.

Aquatic Sciences AQSCA, Vol. 51, No. 2, p 87-99, 1989. 2 fig, 4 tab, 38 ref.

Descriptors: *Water pollution effects, *Eutrophication, *Species composition, *Mussels, *Growth, *Lakes, Switzerland, Bioindicators, Mollusks, Trophic level, Habitats, Ecological effects, Crustaceans, Agricultural runoff, Wastewater pollution, Lake Hallwil.

Species composition, relative abundance and life history of unionid mussels from Lake Hallwil and the outflowing brook were compared between 1915-1919 and 1982-1986 to assess the effects of eutrophication. The recent samples of unionid mussels were collected by divers, and the older ones were from a shell collection. The eutrophication of the lake was caused mainly by agricultural runoff and sewage troughs from housing developments. Living mussels and hard shells from *Unio tumidus* Retz were found at 13 of the 18 sites sampled in the recent mussel collections. Living mussels and hard shells from *Anodonta cygnea* were found at 8 of the 18 sites. Studies of shell growth and winter ring analysis in the old and new mussel collections indicated that mussels from older populations in the mesotrophic lake grew more slowly and died at an older age than mussels in the highly eutrophic Lake Hallwil today. In the outflowing Aabach Brook, the overall abundance of unionid mussels in the recent collections were lower than in 1915-1919, indicating clearly the trend of declining abundance of unionid mussels in Lake Hallwil. Factors affecting the overall decline of unionid mussels in the lake include changes in the fish populations which the mussels depend on in their larval stage, changes in the feeding patterns of predator fish in eutrophic lakes, and invasion of unionid mussel habitat by the zebra mussel *Dreissena polymorpha*. (Geiger-PTT) W90-05385

PREDICTING CHANGES IN HYPOLIMNETIC OXYGEN CONCENTRATIONS WITH PHOSPHORUS RETENTION, TEMPERATURE, AND MORPHOMETRY.

McGill Univ., Montreal (Quebec). Dept. of Biology.

For primary bibliographic entry see Field 2H.

W90-05403

STATE OF POLLUTION IN THE MARINE ENVIRONMENT.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.

M. Waldichuk.

Marine Pollution Bulletin MPNBZ, Vol. 20, No. 12, p 598-602, December 1989. 15 ref.

Descriptors: *Water pollution effects, *Path of pollutants, *Agricultural runoff, *Coastal waters, *Pulp wastes, *Canada, Water pollution control, Air pollution, Regulations, Marine animals, Water pollution sources, International agreements, Ecological effects, Environmental effects.

Coastal pollution problems in Canada are related to the presence of people. Sewage and agricultural and urban runoff have contributed to contamination of oyster-growing waters on both the Pacific and Atlantic coasts causing economic impacts to the shellfish industry. Over the last 75 years, the pulp and paper industry has caused coastal pollution problems, mainly as a result of dissolved oxygen depletion in fishery waters. Coastal pulp-mills in British Columbia have caused elevated levels of dioxins in crustacean shellfish leading to closure of fisheries for crabs, prawns and shrimps in the vicinity of the pulp-mills. Legislation with associated regulations are available to control pollution in coastal waters of Canada and of many other countries, and to prevent consumption of contaminated seafood that might be a hazard to

human health. Globally, there is evidence for a decline in concentrations of certain constituents of four classes of critical contaminants in the marine environment, namely, petroleum hydrocarbons, halogenated hydrocarbons, heavy metals, and radionuclides. The amount of persistent plastics is increasing. Measures to control the discharge of persistent plastics and other refuse from ships are found in Annex V of the International Convention for the Prevention of Pollution from Ships. Two global environmental problems that are still uncontrolled, and which may have ecological impacts on the marine environment are the increasing levels of atmospheric carbon dioxide and other radiatively-active gases which are contributing to climatic change due to a greenhouse effect; and erosion of the stratospheric ozone layer by chlorofluorocarbons and other chemicals, causing increased ultraviolet radiation on the earth's surface. The greenhouse effect may cause changes in distributions of temperature-sensitive fish and invertebrate species that could lead to declines in their populations. Increased UV radiation could adversely affect the sea-surface ecosystems. There is an attempt to control chlorofluorocarbons by international treaty. (Geiger-PTT) W90-05404

BIOLOGICAL AND CHEMICAL COMPOSITION OF BOSTON HARBOR, U.S.A.

Army Engineer Div. New England, Waltham, MA.

For primary bibliographic entry see Field 5B.

W90-05408

ALTERATION OF PHOSPHORUS DYNAMICS DURING EXPERIMENTAL EUTROPHICATION OF ENCLOSED MARINE ECOSYSTEMS.

Rhode Island Univ., Narragansett. Marine Ecosystems Research Lab.

K. R. Hinga.

Marine Pollution Bulletin MPNBZ, Vol. 20, No. 12, p 624-628, December 1989. 5 fig.

Descriptors: *Phosphorus, *Eutrophication, *Ecosystems, *Marine sediments, *Benthos, *Laboratory methods, Cycling nutrients, Silica, Nitrogen, Phosphates, Path of pollutants.

A 28 mo eutrophication experiment was conducted in marine mesocosms at the Marine Ecosystems Research Laboratory of the University of Rhode Island. Each mesocosm contained 13 cu m of seawater and a layer of benthic sediments transferred from adjacent Narragansett Bay. Nitrogen, phosphorus, and silica were added daily to the mesocosms. The net exchanges of phosphorus between benthic sediments and water column were calculated by mass balances. At low loading rates the regular annual pattern of phosphate concentrations is still evident but the amplitude of the pattern is magnified. At high loading rates the annual pattern is lost and the effectiveness of the sediments to act as a buffer to water column concentrations is reduced. In some cases the nutrient loading caused a release of phosphorus from the sediments. (Author's abstract) W90-05410

DDT RESIDUES IN FISHES FROM THE EASTERN ARABIAN SEA.

National Inst. of Oceanography, Panaji (India).

For primary bibliographic entry see Field 5B.

W90-05411

FISHERY IN NATURE RESERVES (FISCHEREI IN NATURSCHUTZGEBIETEN).

Landesamt fuer Wasserversorgung Rheinland-Pfalz, Mainz (Germany, F.R.).

For primary bibliographic entry see Field 81.

W90-05417

COMPARATIVE AQUATIC ECOLOGY RESEARCH ON PHOSPHATE AND PHOSPHATE SUBSTITUTES FOR DETERGENTS (VERGLEICHENDE UNTERSUCHUNGEN ZUR BEWERTUNG VON PHOSPHAT UND PHOSPHATER-

SATZSTOFFEN AUS DER SICHT DER AQUATISCHEN ÖKOLOGIE).

Bayerische Landesanstalt fuer Wasserforschung, Wielenbach (Germany, F.R.).

For primary bibliographic entry see Field 5G. W90-05422

ACUTE ARSENIC INTOXICATION FROM ENVIRONMENTAL ARSENIC EXPOSURE.

Mount Sinai Medical Center, New York. Div. of Environmental and Occupational Medicine.

A. Franzblau, and R. Lilis.

Archives of Environmental Health AEHLAU, Vol. 44, No. 6, p 385-390, November/December 1989. 5 tab, 24 ref.

Descriptors: *Toxicity, *Arsenic, *Wells, Drinking water, New York, Mine drainage, Metals.

Reports of acute arsenic poisoning arising from environmental exposure are rare. Two cases of acute arsenic intoxication in New York resulted from ingestion of contaminated well water. These patients experienced a variety of problems: acute gastrointestinal symptoms, central and peripheral neurotoxicity, bone marrow suppression, hepatic toxicity, and mild mucous membrane and cutaneous changes. Although located adjacent to an abandoned mine, the well water had been tested for microorganisms only and was found to be 'safe'. Regulations for testing of water from private wells for fitness to drink are frequently nonexistent, or only mandate biologic tests for microorganisms. Well water, particularly in areas near mining activity, should be tested for metals. (Author's abstract) W90-05425

PREGNANCY OUTCOMES IN WOMEN POTENTIALLY EXPOSED TO SOLVENT-CONTAMINATED DRINKING WATER IN SAN JOSE, CALIFORNIA.

California Dept. of Health Services, Berkeley. Epidemiological Studies Section.

M. Wrensch, S. Swan, J. Lipscomb, D. Epstein, and L. Fenster.

American Journal of Epidemiology AJEPAS, Vol. 131, No. 2, p 283-300, February 1990. 2 fig, 8 tab, 24 ref.

Descriptors: *Toxicity, *Public health, *Drinking water, *Epidemiology, Birth defects, Miscarriages, Pregnancy, California, Surveys.

During 1980-1981, solvents leaked from an underground storage tank of a semiconductor firm in southern Santa Clara County, California, contaminating local drinking water. The contaminated well was closed in December 1981. An epidemiologic study conducted in 1983 confirmed statistically significant excesses of adverse pregnancy outcomes in an exposed community compared with an unexposed community, but could not establish a causal connection between the leak and the adverse outcomes. This study expanded the first study; adverse pregnancy outcomes occurring in 1980-1985 were studied in two communities exposed to the contaminated drinking water and in two demographically comparable but unexposed communities. The period 1980-1981 was the time period in which the well was considered to have been contaminated and 1982-1985 was considered the postcontamination time period. Both exposed and unexposed communities were considered unexposed during the latter period (1982-1985). Out of 10,055 households surveyed, interviews were conducted with 1,105 women who reported one or more eligible pregnancies. Miscarriages and birth defects were validated by medical record review or physician reports. Although the authors again observed statistically significant excesses of spontaneous abortions and birth defects in the originally studied exposed area in 1980-1981, they observed deficits of these outcomes in the second exposed study area. Adjustment for potential confounders did not alter these findings. Analysis of pregnancy outcomes during 1981 in relation to exposure estimates based on hydrogeologic modeling of water and contaminant distribution within the exposed areas also indicated that the leak was not likely to

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have caused the observed excesses of adverse pregnancy outcomes in the originally studied area. (Author's abstract)
W90-05426

FISHES OF NORTH AMERICA ENDANGERED, THREATENED, OR OF SPECIAL CONCERN: 1989.
Bureau of Land Management, Washington, DC. Endangered Species Committee.
For primary bibliographic entry see Field 81.
W90-05448

EXTINCTIONS OF NORTH AMERICAN FISHES DURING THE PAST CENTURY.
Michigan Univ., Ann Arbor. Museum of Zoology.
For primary bibliographic entry see Field 81.
W90-05449

PHOSPHORUS TRANSFORMATION AND WATER QUALITY IN THE IVANKOVO RESERVOIR: STUDY BY MEANS OF A SIMULATION MODEL.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
A. V. Leonov.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 157-168, November 1989. 1 fig, 7 tab, 20 ref.

Descriptors: *Model studies, *Path of pollutants, *Fate of pollutants, *Reservoirs, *Water quality, *Phosphorus, *Eutrophication, *Mathematical models, *Phytoplankton, *Aquatic bacteria, *Detritus, *Sedimentation, *Bottom sediments, *Mineralization, *Ivankovo reservoir, *Runoff, *Water pollution sources.

Phosphorus transformation and water quality in the Ivankovo reservoir USSR were studied by means of a simulation model. The results of annual average observations of the concentrations of dissolved organic P, dissolved inorganic P, suspended organic P and total P for each season and the different stretches of the reservoir were compared with the concentrations calculated by the model. The average relative error for the entire examined series of data is 28%, which is satisfactory when taking into account the limited amount of information on the external load being used. It is also possible to compare the mean annual concentrations of dissolved inorganic P obtained from observations and those calculated by means of the model. The model permits calculation of the turnover time of P fractions along with the concentrations. P is most rapidly exchanged in biological fractions—in biomass of phytoplankton and bacteria. A high mobility of P was also found in detritus, especially under eutrophication conditions. The calculated turnover times of individual P fractions are close to the times of mineralization of the labile organic matter present in the reservoir water. The information on the inflow of P compounds obtained from the model simulations was used for estimating the P balance on the basis of the average annual data. The amount of P entering the water body with river runoff estimated by the model differs from the literature data by 1.5-5 times. With respect to the total load, the contribution of the river runoff determined in the study is greater than the literature values. It is possible that the literature estimates of P losses to the sediments for the reservoir are underestimated. The contribution of P with precipitation to the reservoir is overestimated by 6-9 times compared with literature values, probably due to the use of its comparatively high concentrations in rain water in modeling. The P loss due to removal by the water outflow through the dam obtained the study is less than the literature values. The total P losses due to accumulation in bottom sediments and removal past the dam determined by the model are comparable to the literature data. (Sand-PTT)
W90-05467

MICROBIOLOGICAL STUDIES OF LAKE ACIDIFICATION: TOXICOLOGICAL IMPLICATIONS.
National Water Research Inst., Burlington (Ontario).

io).
S. S. Rao, B. K. Burnison, and J. O. Nriagu.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 273-284, November 1989. 9 fig, 43 ref.

Descriptors: *Lakes, *Acidic water, *Acid rain effects, *Metals, *Aquatic bacteria, *Water pollution effects, *Toxicity, *Organic matter, *Biodegradation, Ontario, Canada.

Bacteriological and biogeochemical data collected for water and sediment cores from some Ontario lakes receiving acidic deposition indicate that bacterial populations and activities can be diminished by 20-30% under acidic precipitation. Bacterial biodegradation of organic material in acid stressed environments was approximately 30% less than those from non-stressed environments. The decrease in the rate of organic matter degradation might explain the relatively high organic content at the surface sediments of lakes receiving acid precipitation. This suggests that recalcitrant materials found in these ecosystems probably persist for longer periods of time and this could have adverse effects on the overall trophic level in the ecosystem. In addition, atmospheric fallout results in increased loading of pollutant metals that are toxic to biological communities. The various observations on the effects of acid precipitation on the microbial population and its activity in lake sediments are summarized in a conceptual model. Lake acidification is surmised to reduce the bacterial activity and hence increase the organic content of the sediments. The parameters can be used to trace the historical changes in the response of lakes to acid precipitation. (Author's abstract)
W90-05480

ASH BASIN EFFLUENTS AS A CONCERN OF FISHERIES MANAGERS: A CASE HISTORY AND PERSPECTIVE.
Duke Power Co., Huntersville, NC. Production Environmental Services.
L. L. Olmsted, D. J. Degan, and J. S. Carter.
IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 261-269. 3 fig, 4 tab, 22 ref.

Descriptors: *Reservoir fisheries, *Powerplants, *Water pollution effects, *Fish populations, *North Carolina, *Fish management, *Selenium, *Reservoirs, *Water pollution, *Belews Lake, *Fish, *Chemical properties, *Ash.

Belews Lake is a 1564-hectare impoundment for the fossil-fueled Belews Creek Steam Station in North Carolina. Ash from the plant is sluiced to an ash basin, the overflow of which began discharging into the lake in 1975. Water chemistry of the lake is substantially influenced by its long retention time (about 1500 days), its circulation pattern, and the ash basin discharge. The fish community in Belews Lake has reflected changes in water quality from 1976 to the present. Annual rotenone samples prior to power plant operation (1972-1975) revealed a diverse community, dominated by centrarchids, with an average total standing stock of 98 kg/hectare. Samples after initiation of ash basin discharges (1976-1981) showed a progressively less-diverse fish community dominated by non-game fish, with an average standing stock of only 17 kg/hectare. These trends were accompanied by reduced reproduction of most species and a high incidence of blindness in some. Selenium in the ash basin effluent has been implicated as the primary cause of alterations of the fish community. (See also W90-05514) (Author's abstract)
W90-05527

PRELIMINARY RESULTS OF AN EXPERIMENT TO ASSESS THE EFFECT OF SUBSTRATE TYPE ON TREATMENT OF ACID DRAINAGE USING CONSTRUCTED WETLANDS.
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
D. A. Tomljanovich, G. A. Brodie, D. A. Hammer, and T. A. McDonough.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016102.

Price codes: A06 in paper copy, A01 in microfiche. Report No. TVA/ONRED/WRF-8/2, February 1988. 140p, 2 tab, 8 append.

Descriptors: *Acid mine drainage, *Wastewater treatment, *Artificial wetlands, *Substrates, *Coal mining effects, *Iron, *Manganese, *Suspended solids, *Hydrogen ion concentration, *Cattails, *Bulrushes, *Vegetation.

Constructed wetlands are a viable alternative to more costly chemical treatment of acid drainage and are rapidly gaining acceptance, or at least interest of the mining industry, utilities, and regulators. In response to the need for basic information applicable to designing treatment wetlands, the Tennessee Valley Authority (TVA) in 1986 constructed an experimental wetlands facility in Jackson County, AL. The Acid Drainage Wetlands Research Facility consists of twenty 9.1 sq m wetland cells made of half-round fiberglass pipe. A nearby acidic seep was impounded and routed through the cells at controlled rates. Water samples taken biweekly of the influent and wetland cell discharges were compared to assess treatment (reduction in dissolved Fe, Mn, and total suspended solids and elevation of pH) among five substrate types. Secondary comparisons included growth of cattails among substrate types and treatment effects between bulrush and cattail wetlands in the same substrate type. Significant treatment of dissolved Fe and total suspended solids occurred for all substrate types, and a significant rise in pH of about half a standard unit occurred for all substrate types. Significant Mn treatment occurred in four of the six wetland types. However, reduction in concentration was < 1 mg/L in all types. Significant differences among substrate types, by season were rare and inconsistent. Treatment of all parameters improved with time. With one exception, growth and numbers of vegetatively produced cattail stems were not significantly different among substrate types. Comparisons of treatment between cattail and bulrush wetlands were not significant. Preliminary results from the first year of continuous testing suggested substrate type is relatively unimportant in treatment of acid drainage. (Author's abstract)
W90-05559

APPLICABILITY OF AMBIENT TOXICITY TESTING TO NATIONAL OR REGIONAL WATER-QUALITY ASSESSMENT.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5A.
W90-05594

5D. Waste Treatment Processes

ENGINEERS AND OPERATORS NETWORK.
For primary bibliographic entry see Field 7C.
W90-04577

EXPANDING A TEXAS PLANT'S PERFORMANCE.
J. Taylor.
Water Engineering and Management WENMD2, Vol. 136, No. 6, p 41-42, June 1989.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Texas, *Stage treatment, *Aeration, *Chlorination, *Solids contact processes, *Secondary wastewater, *Contact beds.

The original Quail Valley wastewater treatment facility in Texas, which is publicly owned, included a digester, a two-stage aeration tank, a circular clarifier, a chlorine-contact chamber and a belt filter press for sludge dewatering. The 4 million-dollar expansion program was undertaken both to increase capacity and to bring the plant up to the standards required for an advanced secondary wastewater treatment facility. The expansion included the addition of three circular clarifiers, three two-stage aeration tanks and a larger chlorine-contact tank. A sludge-drying incinerator and an expanded control center were added, and the old chlorine-contact chamber was converted to a

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flow-measuring box. Installation of a floating-siphon scum and sludge-collection system upgraded the performance of a new, larger chlorine-contact chamber. A floating bridge travels back and forth the full 85-ft length of the contact chamber. Since completing its expansion program, the Quail Valley plant has consistently surpassed Texas' most stringent municipal-wastewater discharge limits. Although the permit allows a discharge of up to 15 part per million of total suspended solids and 10 ppm of biochemical oxygen demand, the average is closer to 3.5 ppm of total suspended solids and 2.5 ppm of biochemical oxygen demand. (Friedmann-PTT) W90-04578

GASTROINTESTINAL EFFECTS OF WATER REUSE FOR PUBLIC PARK IRRIGATION.
Houston Univ. at Clear Lake City, TX. Bureau of Research.
For primary bibliographic entry see Field 5B. W90-04636

FLOC FORMATION OF ACTIVATED SLUDGE BACTERIA.
Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
A. Kurki, J. Hantula, D. Bamford, and P. Vuoriranta.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1637-1638, 1989. 3 fig, 1 tab.

Descriptors: *Wastewater treatment, *Activated sludge process, *Bacteria, *Flocculation, Biological wastewater treatment, Sewage bacteria, Population dynamics, Species diversity, Microbiological studies.

Flocculation of bacteria was studied in a pilot-scale activated sludge plant fed with synthetic wastewater. Bacterial populations were studied by isolating and characterizing bacteria from floc and dispersed phases. After separation of colonies according to morphology, it was found that 30 to 80% of colonies were morphologically similar. When different colonies were compared to each other by sodium dodecyl sulfate gel-electrophoresis analysis, some of the morphotypes had identical protein patterns, suggesting that they were the same species. Of the two comparison methods, gel-electrophoresis produced better estimates for diversity. The proportion of flocculating species in pure cultures isolated from floc and dispersed phases was similar: 30 to 60% of all species in both phases were at least weakly flocculating. Non-flocculating variants were separated from readily flocculating species. After isolation of the phages against one of the flocculating variants, the efficiency of plating on the corresponding non-flocculating variant was 1% of that of the flocculating variant. In coflocculation tests between flocculating and non-flocculating bacteria, flocculating inhibition was found. This was also true between two different flocculating species, but at a lower level. (Cassar-PTT) W90-04733

INFLUENCE OF CONTACT LOADING ON POLYSACCHARIDE STORAGE AND SETTLEABILITY OF ACTIVATED SLUDGE.
Kanazawa Univ. (Japan). Dept. of Civil Engineering.
R. Yamamoto, and S. Matsui.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1639-1642, 1989. 5 fig, 1 tab, 6 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Settling velocity, Contact loading, Polysaccharides, Biological wastewater treatment, Bulking sludge, Bacteria, Organic loading, Aeration, Microbiological studies.

Activated sludges were cultivated under several contact loadings, using a substrate of glucose and peptone. Contact loading means the instantaneous contact ratio of substrate to sludge. Microorganisms with a large polysaccharide storage capacity (M1) were dominant when the contact loading was high, while microorganisms with small polysaccharide storage capacity (M2) could coexist with the

M1 when the contact loading was low. When aeration time was not sufficient to restore the storage capacity, the M2 group could coexist with M1 although contact loading was high. Filamentous bacteria were believed to belong to the M2 group. (Cassar-PTT) W90-04734

FIXED BIOMASS CARRIERS IN ACTIVATED SLUDGE PLANTS.
Centre de Recherche de Maisons-Laffitte (France).
F. Rogalla, G. Bacquet, M. Bonhomme, and M. Boisseau.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1643-1646, 1989. 4 fig, 1 tab, 12 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Settling velocity, *Biomass carriers, Sludge volume index, Biological wastewater treatment, Aeration.

The addition of fixed biomass carriers to existing activated sludge basins was a feasible remedy for overloaded conditions. Studies were conducted in a 40,000-cu m/day plant serving 250,000 inhabitants in Le Mans, France. The BIOFIX system consisted of modular corrugated cross-flow type plastic media with a surface area of 100 sq m/cu m, allowing good penetration of the spiral flow. The media was attached to a support structure below the aeration grids, filling about 20% of the tank volume for the first test and about 40% for the second test. Three months of measurements were obtained on each system after a one-month seeding period. The beneficial effect of the fixed biomass was more evident at high loadings. With 20% packing the plant effluent was upgraded from 30 mg/l BOD to 20 mg/l BOD at the same load. For 40% packing the effluent quality became independent of the load and stabilized at about 20 mg/l. COD results reflected BOD results. The COD mass per day and reactor volume to reach the same effluent quality was extended by 1.5 kg COD/cu m/day with 20% packing. The same value was obtained by adding 40% media, but at a lower level. The percentage gain in acceptable load varied between 30% improvement at 20% packing to 50% improvement at 40% packing. The increase in efficiency due to adding biomass was highly dependent on initial treatment quality and was proportional to overloading conditions. (Cassar-PTT) W90-04735

APPLICATION OF MICROSCOPIC EXAMINATION OF ACTIVATED SLUDGE TO OPERATIONAL CONTROL.
Southern Water Authority, Chatham (England). Kent Div.
S. R. Wilson, and J. R. Wharfe.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1647-1650, 1989. 5 fig, 1 tab, 1 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Bacteria, Biological wastewater treatment, Bulking sludge, Flocculation, Microbiological studies, Sewage bacteria, Microthrix, Thiothrix.

Microscopic examination of floc structure, fauna, and filamentous bacteria in activated sludge showed that these parameters could serve as indicators for operational control. For example, breakdown of floc structure, as seen by excessive dispersal of bacteria, indicates poor treatment with a resultant turbid effluent—probable causes, toxicity and/or excessive agitation. Diagnostic features, problems encountered, results, and causes are tabulated for very large compact flocs, presence of flagellates, diversity of ciliates and rotifers, and type of filamentous bacteria observed. A great diversity of fauna indicates a sludge more adaptable to environmental changes as well as good conditions for nitrification. Problems are seen with excessive growth of *Microthrix parvicella* (bulking sludge and foaming) and monoculture of *Thiothrix* sp. (poor treatment). (Cassar-PTT) W90-04736

SEQUENCING BATCH REACTOR ACTIVATED SLUDGE PROCESSES FOR THE TREAT-

MENT OF MUNICIPAL LANDFILL LEACHATE. REMOVAL OF NITROGEN AND REFRACTORY ORGANIC COMPOUNDS.

National Inst. for Environmental Studies, Tsukuba (Japan).
M. Hosomi, K. Matsusige, Y. Inamori, R. Sudo, and K. Yamada.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1651-1654, 1989. 3 fig, 2 tab, 13 ref.

Descriptors: *Water pollution treatment, *Water pollution prevention, *Leachate treatment, *Wastewater treatment, *Waste disposal, *Activated sludge process, *Leachates, *Landfills, *Nitrification, Organic compounds, Biological wastewater treatment, Organic carbon, Laboratory methods, Nitrogen removal, Sequencing batch reactor, Ozonation, Oxidation.

Laboratory-scale experiments were conducted on removal of nitrogen and refractory organic compounds in municipal landfill leachates using the sequencing batch reactor activated sludge process with biological nitrification-denitrification. Nitrogen concentrations in the leachates ranged from 100 to 330 mg/l. Nitrogen removal experiments involved a variety of mixing, aeration, and methanol addition conditions. It was necessary to add methanol as a hydrogen donor in ratios of at least 2.5 methanol to ammonium-nitrogen. Greater than 90% nitrogen removal was obtained with ammonium-N loading less than 0.05 kg/cu m/day and anoxic and aerobic periods longer than 4 hours each. The COD levels in the leachate were in the 100 to 150 mg/l range. COD and total organic carbon removals were 50.8% and 43.9%, respectively, with preliminary ozonation, compared to 37.6% and 27.5%, respectively, without ozonation. (Cassar-PTT) W90-04737

BIOPHYSICAL TREATMENT FACILITY FOR HAZARDOUS WASTE LANDFILL LEACHATES.

BKK Corp., West Covina, CA. Landfill Div.
A. Lebel, R. Meeden, and B. A. Stirrat.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1655-1656, 1989. 1 tab, 2 ref.

Descriptors: *Water pollution treatment, *Water pollution prevention, *Leachate treatment, *Wastewater treatment, *Waste disposal, *Activated sludge process, *Leachates, *Landfills, Organic compounds, Groundwater pollution, Activated carbon.

Leachate from a sanitary landfill accepting both municipal and hazardous wastes was treated in the BKK Leachate Treatment Plant in West Covina, CA. The plant, using a suspended-growth biological system with addition of powdered activated carbon, was designed as a modular system with an initial capacity of 50,000 gpd, expandable to 100,000 gpd. It operated as an extended aeration system, with hydraulic retention time of 3 days and a mixed-liquor activated carbon level of 5000 mg/l. COD/BOD removals were over 95% for an influent of 1900 mg/l COD and 850 mg/l BOD. The effluent was odorless and colorless, with a suspended solids level of <100 mg/l and a quality suitable for irrigation and dust control. (Cassar-PTT) W90-04738

COMPUTER MODELLING OF ALGAL WASTE TREATMENT SYSTEMS.

West of Scotland Agricultural Coll., Auchincruive. Dept. of Microbiology.
N. J. Martin, and H. J. Fallowfield.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1657-1660, 1989. 3 fig, 1 ref.

Descriptors: *Model studies, *Wastewater treatment, *Ponds, *Algae, *Computer models, *Biological wastewater treatment, Photosynthesis, Productivity, High Rate Algal Pond, Australia, Seasonal variation.

The Grobbelaar, Soeder and Stengel computer model for algal productivity and oxygen produc-

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tion in large scale outdoor cultures was modified to calculate and store daily production rates in each 1-cm layer from 1 to 40 cm depth. Results are calculated for 9 different biomass concentrations (25, 50, 100, 150, 200, 250, 300, 350, and 400 mg C/l) and for each month of the year. This program can be used to calculate the parameters for High Rate Algal Pond design. Three options are available: calculation of the pond configuration for optimum treatment, biomass production, and calculation of a fixed area configuration. The user is requested to input the BOD and the daily flow rate for the wastewater, the flow velocity in the mixed pond, and the month for which data is required. An example is presented using a hypothetical pond in Melbourne, Australia, treating 800 cu m/day of 350 mg BOD/l wastewater. Pond area is inversely related to the oxygen production rate/sq m. There is a five-fold difference between the most favorable and least favorable months. At this location the minimum oxygen production rate (and maximum pond area) are in midwinter due to reduced insolation and in midsummer due to severe photoinhibition. (Cassar-PTT) W90-04739

LEAD REMOVAL FROM CONTAMINATED WATER BY A MIXED MICROBIAL ECOSYSTEM.

Morehouse Coll., Atlanta, GA. Dept. of Biology. J. A. Bender, E. R. Archibald, V. Ibeanusi, and J. P. Gould. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1661-1664, 1989. 3 fig, 2 ref. Bureau of Mines Grant G0145031, Department of Energy Contract C86-11-0866, National Institutes of Health Grant RR-8006.

Descriptors: *Wastewater treatment, *Lead, *Heavy metals, *Biological wastewater treatment, *Algae, Cyanophyta, Biomass, Ecosystems, Metals, Laboratory methods.

Ecosystems were prepared by adding anaerobically digested grass clippings and lead-adapted blue-green algae to sandy-loam soil in 3 liters of water contained in clear plastic tanks. Lead nitrate was added at a level of 300 mg tank nine times over the 30-day test. Daily lead analyses showed that lead was transported from the water column to the surface mat at about the fourth day, when the algal phase began. However, bacteria were also active in the transport process; lead accumulated in the soil when bacteria were not added to the ecosystems. Of the 300 mg lead added to a tank, about 235 mg was found in the floating mat after 9 days, the remainder in the soil and water column. It was postulated that sulfide produced in the anaerobic mat allowed precipitation of lead sulfide. Under optimum conditions this ecosystem sequestered lead at a rate of 23 ± 6 mg/l/d and concentrated the metal in the biomass at levels of 0.15 mg lead/mg biomass. This was greater than the uptake capacity of the algal component cultured alone under ideal conditions. (Cassar-PTT) W90-04740

SEWAGE TREATMENT IN CONSTRUCTED REED BEDS-DANISH EXPERIENCES.

Aarhus Univ. (Denmark). Botanical Inst. H. Brix, and H. H. Schierup. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1665-1668, 1989. 1 fig, 1 tab, 7 ref.

Descriptors: *Artificial wetlands, *Wastewater treatment, *Land disposal, *Wetlands, *Macrophytes, *Vegetation, *Nutrient removal, Reeds, Nitrogen, Phosphorus, Denmark, Nitrification, Roots, Rhizosphere, Biological wastewater treatment, Wastewater disposal, Municipal wastewater, Biological oxygen demand.

Twenty-five reed beds constructed in Denmark for wastewater disposal were evaluated. The majority of the reed treatment beds were constructed to treat only mechanically pretreated domestic sewage. Removal efficiency with respect to BOD was typically 70 to 90% after one growing season, producing an effluent concentration of less than 20 mg/l. Total nitrogen and total phosphorus were reduced by 25 to 50% and 20 to 40%, respectively.

The poor performance of nutrient removal was attributed to low soil permeability and insufficient release of oxygen from the root systems for adequate nitrification. Only reed beds with loading rates of <2 cm/d produced nitrogen and phosphorus removal of $>50\%$. Soil permeability did not improve significantly even after 4 growing seasons. Overland flow predominated. (Cassar-PTT) W90-04741

CROP PRODUCTION AND SEWAGE TREATMENT USING GRAVEL BED HYDROPONIC IRRIGATION.

Portsmouth Polytechnic (England). Dept. of Civil Engineering.

J. E. Butler, R. F. Loveridge, and D. A. Bone. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1669-1672, 1989. 6 tab, 6 ref.

Descriptors: *Secondary wastewater treatment, *Wastewater treatment, *Impaired water use, *Irrigation, *Hydroponics, *Macrophytes, *Vegetation, Cultures, Biological wastewater treatment, Crop production, Gravel, Reeds, Beets, Nutrient removal, Nitrogen, Phosphorus removal, Wetlands, Suspended solids, Biological oxygen demand.

A field-scale two-stage sewage treatment/crop production system was constructed using a series of gently sloping channels, each lined with an impermeable membrane and filled with gravel aggregate. The primary stage was planted with a selection of reeds and grasses and fed with settled sewage. The secondary stage was planted with a commercial crop of sugar beets, which received effluent from the reed system. BOD removal (125 mg/l in the influent) was 34% in the Phragmites planting, 25% in the thin Spartina stand, 32% in the dense Spartina stand, and 43% in the Carex planting. Suspended solids removal (97 mg/l in the effluent) was 34% in the Phragmites planting, 53% in the thin Spartina stand, 41% in the dense Spartina stand, and 51% in the Carex planting. The sugar beet secondary system consisted of inclined gravel beds fed with effluent from the reed system. Removals of substances from this secondary system were as follows: BOD, 68% (to 27 mg/l); suspended solids, average 41% (to 30 mg/l); ammonia, 29% (to 5.0 mg/l); phosphate, 6% (to 11.3 mg/l). The sugar beets obtained from the reed-fed system had a mean root weight of 380 g compared with 846 g in the conventionally fed crop. These disappointing results were attributed to an under-designed primary stage which delivered a too-strong feed. (Cassar-PTT) W90-04742

EFFECT OF C/N/P RATIO ON THE PERFORMANCE OF A DOWNFLOW STATIONARY FIXED FILM REACTOR (DSFR) WORKING AT LOW ORGANIC LOADING RATES.

Santiago Univ. (Spain). Dept. of Chemical Engineering.

R. Mendez, L. M. Pan, and J. M. Lema. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1673-1676, 1989. 4 fig, 4 tab, 3 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Nutrients, Downflow stationary fixed film reactors, Biological wastewater treatment, Organic loading, Digestion, Nitrogen, Phosphorus.

The performance of downflow stationary fixed film reactors was studied at three ratios of C/N/P: 250/1.5/1 (balanced), 250/7.5/1 (low-nitrogen); and 250/7.5/0.2 (low-phosphate). Significant differences in performance were observed. The bacterial concentration in the liquid of the balanced substrate digester was less than in the other digesters and consisted mainly of isolated cocci. The liquid of the low-nitrogen digester contained aggregated cocci. The liquid of the low-phosphate digester contained mainly filamentous bacteria. The balanced digester more rapidly removed 1 g/l pulses of acetic acid, propionic acid, butyric acid, and lactose than the low-nitrogen digester. (Cassar-PTT) W90-04743

PERFORMANCES OF CHARCOAL CHIP AND SAND PACKED ANAEROBIC REACTORS.

National Univ. of Singapore. Dept. of Civil Engineering.

K. K. Chin. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1677-1680, 1989. 3 fig, 2 tab, 3 ref.

Descriptors: *Food-processing wastes, *Wastewater treatment, *Anaerobic digestion, *Industrial wastes, Digestion, Biological wastewater treatment, Sand, Charcoal, Fixed film reactors, Oil wastes, Organic loading, Shock loads, Sulfate.

Performances of anaerobic fixed film reactors were studied using 200-l field units packed with 20 mm equivalent diameter charcoal chips and 7-l laboratory units packed with charcoal chips and 0.35 mm sand particles. Wastewaters from edible oil refineries were used as feed. Treatment efficiency was $>80\%$ at organic loading rates of 7 kg COD/cu m/d and 60% at 12 kg COD/cu m/d. The systems were able to withstand a shock loading of >22 kg COD/cu m/d. Efficiency dropped when wastewater contained a high concentration of sulfate and sodium. The gas production rate was generally greater than 0.26 cu m/kg COD removed, of which 80% by volume was methane. (Author's abstract) W90-04744

ANAEROBIC FLUIDIZED-BED TREATMENT OF BREWERY WASTES AND BIOENERGY RECOVERY.

Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.

I. Ozturk, G. K. Anderson, and C. B. Saw. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1681-1684, 1989. 6 fig, 1 tab, 3 ref.

Descriptors: *Wastewater treatment, *Pilot plants, *Anaerobic digestion, *Industrial waste, Biological wastewater treatment, Fluidized beds, Fermentation, Brewery waste, Methane, Biogas.

Brewery wastes were treated in a pilot-scale anaerobic fluidized bed reactor. A COD removal efficiency of $>75\%$ was obtained at an organic loading rate of 9.5 kg COD/cu m/d for a period of 82 days from startup. COD removal efficiency was $>74\%$ at an organic loading rate of 14.6 kg COD/cu m expanded bed/day. A COD to methane conversion of 87% was achieved. Experimental results suggested that the COD removal efficiency of this type of reactor was only a function of COD loading, and neither the feed COD nor hydraulic retention time significantly affected the reactor performance. A linear relationship was found between the specific substrate utilization rate and the specific methane production rate. The distribution of the biomass along the height of the reactor was not uniform, and the biomass holdup near the top of the reactor sometimes reached concentrations of $>20,000$ mg/l. (Author's abstract) W90-04745

DECOMPOSITION OF PENTACHLOROPHENOL BY ANAEROBIC DIGESTION.

National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.

A. Kudo. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1685-1688, 1989. 2 fig, 9 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Pentachlorophenol, *Industrial wastes, *Phenols, Chemical wastes, Pulp and paper industry, Biological wastewater treatment, Digestion.

Pentachlorophenol (PCP) (0.5 to 10 ppm) mixed with radioactively labeled PCP was digested for 50 days in laboratory-scale reactors as follows: (1) control, (2) pure acidogenic sludge with artificial wastewater, (3) mixed anaerobic sludge with artificial wastewater, (4) acclimatized anaerobic sludge with pulp and paper waste and artificial wastewater, and (5) acclimatized sludge with artificial wastewater only. The PCP decomposition rate increased with time in most reactors. The highest decomposition rate was obtained in reactors (4)

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and (5). The lowest decomposition rate was seen in reactor (2). There was a 50-fold difference in decomposition rate among the experimental conditions at days 25 to 30. (Cassar-PTT) W90-04746

DYNAMICS OF PROTONS IN ACTIVATED CARBON. HYDROGEN-1 NMR STUDIES.

Ecole Nationale Supérieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Génie de l'Environnement.

P. Le Cloirec, G. Martin, and J. Gallier.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1693-1696, 1989. 4 fig, 2 tab, 11 ref.

Descriptors: *Regeneration, *Wastewater treatment, *Activated carbon, Nuclear magnetic resonance, Phenols, Adsorption.

Protons in the inner structure of activated carbon were studied using solid state nuclear magnetic resonance. Both pure carbon and carbon saturated with phenol were included in the experiments. For fresh carbon, mobile water covered all the porous surfaces and exchanged quickly with a small amount of bound water. For phenol-saturated carbon, a majority of the water molecules moved out of the pores during adsorption. Three possibilities for mechanisms of interaction between phenol and activated carbon were proposed: (1) phenol attached directly to the carbon surface with the phenol ring parallel to the carbon surface, (2) a water molecule between the phenol and carbon, with the phenol ring perpendicular to the carbon surface, (3) phenol attached directly to the carbon surface with the ring parallel to the carbon surface, but a water molecule also connected to both phenol and carbon surface. (Cassar-PTT) W90-04748

EVALUATION OF CHEMICAL AND THERMAL REGENERATION OF ACTIVATED CARBON.

National Taiwan Univ., Taipei. Inst. of Environmental Engineering.

P. C. Chiang, and J. S. Wu.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1697-1700, 1989. 2 fig, 2 tab, 5 ref.

Descriptors: *Wastewater treatment, *Activated carbon, Adsorption, Phenols, Chemical wastes, Industrial wastes, Organic compounds, Aromatic compounds, Aminophenol, Chlorophenol, Naphthol, Dyes, Chlorobenzene, Naphthalene, Naphthylamine, Chloronaphthalene.

The effects of nine typical aromatic compounds on the desorption efficiency of activated carbon were compared using chemical regeneration (methanol, ethanol, or sodium hypochlorite) and thermal regeneration. Chemical regeneration efficiencies for activated carbon exhausted with the organic contaminants, using ethanol as the optimum solvent, were as follows: phenol, 81.11%; 2-aminophenol, 55.20%; aniline, 96.8%; 2-chlorophenol, 52.14%; chlorobenzene, 51.20%; beta-naphthol, 27.81%; naphthalene, 15.15%; alpha-naphthylamine, 42.11%; and alpha-chloronaphthalene, 52.75%. For phenolic and benzyl compounds, the chemical regeneration efficiency decreased with an increase in the molecular weight of the adsorbate. However, for naphthyl compounds the regeneration efficiency increased with an increase in the molecular weight of the adsorbate. In thermal regeneration the efficiency was independent of the adsorbate characteristics, but was highly related to the weight loss coefficient of the activated carbon during the thermal oxidation process. In this study regeneration efficiencies of 75 to 86% were obtained. Annual costs for chemical regeneration were computed at about half the costs for thermal regeneration. (Cassar-PTT) W90-04749

USE OF COCONUT SHELL-BASED ACTIVATED CARBON FOR CHROMIUM (VI) REMOVAL.

International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).

G. J. Alaerts, V. Jitjaturant, and P. Kelderman.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1701-1704, 1989. 2 fig, 1 tab, 5 ref.

Descriptors: *Wastewater treatment, *Activated carbon, *Heavy metals, *Industrial wastewater, *Metal-finishing wastes, Hydrogen ion concentration, Chemical wastes, Chromium, Adsorption, Electroplating.

Effective removal of chromium(6+) from acidic electroplating wastewaters was achieved by adsorption on coconut shell-based activated carbon (MD-W7830) as well as Filtrasorb 400, Norit SX1, and Norit SX4. Batch experiments used a 50-ml volume of chromium solution. For an initial pH of 2.5 and carbon dosage of 5 g/l, the final pH for the 20, 50, and 100 mg/l chromium solutions were 3.21, 5.6, and 6.4, respectively. For the same initial pH of 2.5 and a Cr concentration of 50 mg/l, the final pH for dosages of 1, 3, and 5 g/l carbon were 3.1, 4.6, and 7.1, respectively. Using the coconut shell-based carbon, 94% removal was observed after 4 hr of contact time, whereas 82% and 88% removals were observed after 20 min and 1 hr, respectively. Removal efficiencies at an initial pH of 2.5 and carbon dosage of 10 g/l were 47%, 57%, and 99% for chromium concentrations of 350, 150, and 20 mg/l chromium, respectively. It was important to prevent pH from rising above 7 during the process. The mechanism of chromium removal involved adsorption onto the activated carbon and catalytic reduction to Cr(3+). (Cassar-PTT) W90-04750

REMOVAL OF CADMIUM FROM WATER BY THE USE OF BIOLOGICAL SORBENTS.

King's Coll., London (England). Div. of Biosphere Sciences.

M. Salah Azab, and P. J. Peterson.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1705-1706, 1989. 1 fig, 1 tab.

Descriptors: *Wastewater treatment, *Adsorption, *Industrial wastewater, *Heavy metals, Metals, Cadmium, Activated carbon, Biomass, Compost, Laboratory methods, Peat.

Absorption of a solution of 100 ppm cadmium by a variety of sorptive materials was studied on a laboratory scale. Approximate sorption efficiency of materials as estimated from a graph were as follows: human hair, 40%; bone, 93%; apricot seed shell, 35%; walnut shell, 45%; peanut shell, 70%; orange skin, 80%; peat, 90%; compost, 95%; Zygorhynchus, 95%; Rhizopus, 98%; Mucor ramanianus, 95%; Penicillium, 70%; Aspergillus terreus, 78%; Ionex ion exchange resin, 7%, and activated charcoal, 65%. Alkaline treatment increased adsorption capacity as high as 50% for some substances. The Cd adsorption for alkaline treated substrates were as follows: activated charcoal, 87.0%; Aspergillus terreus, 94.2%; Mucor ramanianus, 54.0% (less than the untreated sorbent); natural compost, 97.1%; Irish peat, 93.2%; peanut shell, 99.0%; walnut shell, 99.5%; and bone, 99.1%. (Cassar-PTT) W90-04751

ASSESSMENT OF ACTIVATED SLUDGE SYSTEMS PRACTICING POWDERED ACTIVATED CARBON ADDITION WITH WET AIR REGENERATION.

Weston Services, Inc., West Chester, PA.

K. J. Deeny, J. A. Heidman, and A. J. Condren.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1707-1710, 1989. 2 fig, EPA Contract 68-03-3429.

Descriptors: *Wastewater treatment, *Activated sludge process, *Activated carbon, Adsorption, Wet air regeneration process, Nitrification, Biological wastewater treatment, Biological oxygen demand, Suspended solids, Nitrification, Color removal.

Powdered activated carbon (PAC) addition to activated sludge systems in 11 municipal wastewater treatment plants was evaluated. The process involves addition of virgin PAC to the aeration tanks to maintain a concentration of 3000 to 6000 mg/l.

Polymer is added before the secondary clarifiers. A slip stream of return activated sludge is conveyed to a gravity thickener and the underflow is pumped to the wet air regeneration unit. Tertiary filters are used to prevent escape of PAC particles. Carbon addition produces high efficiency in BOD and suspended solids removals and enhances nitrification, color removal, and the removal of slowly degradable or nonbiodegradable compounds. Coupling a wet air regeneration unit with the PAC results in several problems: recycling of BOD, ammonia, and insoluble phosphates; buildup of insoluble metallic salts; poor effluent quality; ash accumulation in mixed liquor suspended solids; inaccuracy in PAC concentration measurement; incomplete biomass oxidation; tertiary filter loading; and additional operations and maintenance requirements. Useful modifications to mitigate these problems include limiting the running time of the regeneration unit, using a lower ash content PAC, reducing the PAC addition rates, using unactivated carbon, eliminating the regeneration process, using ash separation, blowing down the regeneration slip stream to sludge disposal, and conversion to conventional activated sludge system operation. (Cassar-PTT) W90-04752

MANGANESE: A NECESSARY MICRONUTRIENT TO ENHANCE BIOLOGICAL PHOSPHORUS REMOVAL.

D. Davelaar.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1711-1716, 1989. 5 fig, 3 tab, 9 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Nutrients, *Phosphorus removal, *Manganese, Metals, Heavy metals, Nutrients, Biological wastewater treatment, Iron.

The disciplines of engineering and microbiology were separately applied to the problem of microbiological phosphorus removal in the activated sludge process. The engineering results indicated that an acetate-fed reactor produced poor removal (only 28% of total P) because it was deficient in a substance present in the more efficient reactor which was fed with whole dairy waste. It was believed that the deficient substances were manganese and iron. The microbiological tests showed that addition of ferric chloride to the acetate-fed reactor did not improve P removal. However, addition of manganese chloride (1.7 mg Mn/l mixed liquor) caused an immediate increase in dissolved oxygen level and decrease in P concentration. (Cassar-PTT) W90-04753

KINETICS OF PHOSPHORUS RELEASE AND UPTAKE BY MICROORGANISMS UNDER CYCLIC ANAEROBIC/AEROBIC CONDITIONS-EXPERIMENTAL STUDY.

Tokyo Univ. (Japan). Inst. of Industrial Science.

M. Suzuki, and C.-H. Yoon.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1717-1720, 1989. 3 fig, 2 tab.

Descriptors: *Wastewater treatment, *Nutrient removal, *Phosphorus removal, *Anaerobic conditions, Biological wastewater treatment, Aerobic conditions, Kinetics, Microorganisms, Organic carbon.

A kinetic model for phosphorus and organic carbon behavior in microorganisms under anaerobic/aerobic conditions is described. The P release step under anaerobic conditions is divided into two phases; it provides the energy for organic substrate storage and for microorganism maintenance. The rate of P release is affected by the content of P in the microorganism, accumulated as polyphosphate. Thus, the rate of P release is controlled by the concentration of biodegradable organic substrate in the mixed liquor. Phosphorus taken up from solution under aerobic conditions is used for polyphosphate accumulation and organism growth. The rate of P uptake at the start of aeration is determined by the difference between the maximum possible P content and the actual P content. The rate of P uptake is also controlled by the stored organic

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substrate in the microorganisms and/or the biodegradable organic substrate concentration of the mixed liquor. A plot of P concentration (6, 12, and 24 mg/l) for mixed liquor suspended solids concentrations of 2500, 4500, and 6500 mg/l shows that the P release rate under anaerobic conditions is very high during the first 1 hr. As the organic substrate concentration decreases, the P release rate also slows. At the start of aeration, P concentration in the mixed liquor decreases rapidly, due to microorganism uptake. Kinetic constants were derived for anaerobic and aerobic conditions. (Cassar-PTT)
W90-04754

FRACTIONATION OF BIOACCUMULATED PHOSPHORUS COMPOUNDS IN ACTIVATED SLUDGE.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. D. W. de Haas.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1721-1725, 1989. 2 fig, 1 tab, 12 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Nutrient removal, *Phosphorus removal, Bioaccumulation, Accumulation, Biological wastewater treatment.

Two fractionation procedures were used to extract chemical precipitate and acid-soluble polyphosphate in activated sludge. Procedure A used 1% trichloroacetic acid; Procedure B used 0.5 M perchloric acid. Both procedures gave excellent recoveries of phosphorus, 81 to 102%. Sludge from two laboratory units and two full-scale units were studied. Polyphosphate represented the major storage form of phosphorus (61 to 83% total P) in the sludges, except for a laboratory sludge fed with acetate and a full-scale unit receiving mainly industrial effluent. Nucleic acids represented a fairly constant amount of P (0.6 to 1.2 mg P /g mixed liquor suspended solids). Metal cations were largely coextracted with the major phosphate fractions. No simple molar ratio between the metals and ortho-, or polyphosphate could be obtained except in the following cases: perchloric acid-extracted polyphosphate from laboratory units 1 and 2, where a molar ratio of positive cation charge to phosphorus ranging from 1.1 to 1.2 was obtained; and EDTA-, or trichloroacetic acid-extracted orthophosphate from laboratory unit 1, where positive cation charge to P ratios were about 1.2 and 1.9, respectively. Potassium ion was most important, followed by Mg and Ca. (Cassar-PTT)
W90-04755

BIO-DENITRO AND BIO-DENIPHO SYSTEMS - EXPERIENCES AND ADVANCED MODEL DEVELOPMENT. THE DANISH SYSTEMS FOR BIOLOGICAL N AND P REMOVAL.

Krouger (I.) A/S, Søborg (Denmark). Research and Development Div.
E. Bundgaard, K. L. Andersen, and G. Petersen.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1727-1730, 1989. 2 fig, 3 tab.

Descriptors: *Wastewater treatment, *Activated sludge process, *Nutrient removal, *Phosphorus removal, *Nitrogen removal, BIO-DENITRO process, BIO-DENIPHO process, Biological wastewater treatment, Nitrification, Denitrification, Model studies.

The BIO-DENITRO (biological nitrogen removal) and BIO-DENIPHO (biological nitrogen and phosphorus removal) nutrient removal processes are performed in isolated ditches which are continuous flow, activated sludge systems with phased or intermittent operations. Operating results are shown for several Bio-Denitro and Bio-Denipho plants in Denmark. Total P in the effluents ranged from 0.6 to 3.9 mg/l; total N in the effluents ranged from 3.4 to 6.8 mg/l. Data from one plant were compared with predicted results from a model. Effluent from the Bio-Denitro process was as good as that obtained from the recirculation system. However, the Bio-Denitro process was more flexible for use with wastewater with changing COD/N ratios. (Cassar-PTT)
W90-04756

BIOLOGICAL NUTRIENT REMOVAL WITH SLUDGE BULKING CONTROL IN A BATCH ACTIVATED SLUDGE SYSTEM.

Transfield, Inc., Irvine, CA.
M. C. Goronszy, and J. White.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1731-1734, 1989. 1 fig, 5 tab, 4 ref.

Descriptors: *Wastewater treatment, *Nutrient removal, *Activated sludge process, *Phosphorus removal, *Nitrogen removal, Biological wastewater treatment, Bulking sludge, Flocculation.

Nutrient removal was studied in a cyclically operated batch reactor with the following configuration: an initial nonaerated anaerobic reactor, a non-aerated mixed secondary reaction zone of variable hydraulic retention time, and a final zone which is sequentially aerated and nonaerated. Experimental operating conditions showed that activated sludge bulking was prevented while operating on a nitrogen and biological phosphorus removal mode, provided a proper soluble substrate balance was maintained. This suggested the existence of a threshold soluble substrate concentration that favors the growth of filamentous microorganisms. (Cassar-PTT)
W90-04757

EFFICACY AND MECHANISM OF REMOVAL OF ORGANIC SUBSTANCES FROM WATER BY OZONE AND ACTIVATED CARBON.

Jilin Architectural and Civil Engineering Inst., Changchun (China). Dept. of Urban Engineering. J. Yin, and B. Wang.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1735-1737, 1989. 2 fig, 2 ref.

Descriptors: *Water treatment, *Wastewater treatment, *Ozonation, *Disinfection, *Activated carbon, Oxidation, Organic compounds, Aromatic compounds, Nitrobenzene, Dinitrobenzene, Nitrotoluene, Nitroanilines, Formaldehyde, Tannins, Adsorption, Nitrogen removal.

Ozone doses up to 30 mg/l were applied to solutions of a variety of organic compounds to test removal efficiency. Vulnerability to ozonation was as follows: tannin > p-nitrotoluene > nitrobenzene > p-dinitrobenzene > p-nitrotoluene > m-dinitrobenzene > formaldehyde. The nitro-compounds produced nitrite during ozonation, with p-nitroaniline producing the most and p-nitrotoluene the least. Upon ozonation, intermediate products were formed which were oxidizable by potassium permanganate but not readily oxidizable by ozone. The order of adsorption capacity of activated carbon for the compounds studied was as follows: o-dinitrobenzene > p-nitrotoluene > p-dinitrobenzene > m-dinitrobenzene, > p-nitroaniline > nitrobenzene > phenol > tannins. Nitrification was complete in the ozonation-activated carbon process, with the formation of nitrate under oxygen-sufficient conditions in the carbon bed. (Cassar-PTT)
W90-04758

ODOR CHARACTERIZATION AND CONTROL IN A CHEMICAL WASTEWATER EQUALIZATION BASIN.

Temple-Eastex, Inc., Diboll, TX.
J. P. Moore, and E. M. Davis.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1739-1742, 1989. 6 tab.

Descriptors: *Wastewater treatment, *Odor control, *Equalizing basins, *Industrial wastewater, Organic compounds, Chemical wastewater, Oxidation, Ozonation, Hydrogen peroxide, Chlorination, Lime.

Odors emanating from an industrial chemical wastewater equalization basin were believed to originate in the sediments as a result of bacterial action. The highly variable wastewater was likely to contain polyols, toluene, monochlorobenzene, antioxidants, hexamethylenediamine, butyl acetate, and potassium sulfate. Several odor control methods were tested. Hydrogen peroxide up to 11,250 mg/l had little effect on odors. Ozonation at doses

of 0.43 mg/min and higher had some residual effect for odor control. Chlorination at high concentrations worked well at reducing odor intensities, but only maintained that effect when sediment was not present. Lime addition had the most profound long-term effects on odors, but this effect was achieved only at very high doses. (Cassar-PTT)
W90-04759

ACTIVITY OF PERACETIC ACID AGAINST SEWAGE INDICATOR ORGANISMS.

Interox S.A., Widnes (England). Research and Development.
M. G. C. Baldry, and M. S. French.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1747-1749, 1989. 2 tab, 2 ref.

Descriptors: *Wastewater treatment, *Disinfection, *Sewage bacteria, *Bacteria, Peracetic acid, Bioindicators, Laboratory methods, Biocides, Viruses, Microbiological studies, Poliovirus.

In standardized laboratory tests, peracetic acid was an effective disinfectant of bacteria and viruses found in sewage. A table lists the microorganisms (*Escherichia coli*, *Streptococcus faecalis*, bacteriophages MS2 and O₁₅₇, and poliovirus) and the minimum required concentration of peracetic acid for demineralized water, sewage effluent of pH 5, 7, and 9; and water with yeast extract. Minimum conditions (peracetic acid concentration and contact time) to achieve >1000 reduction in bacterial numbers are given for several stages of sewage treatment, from raw wastewater to clarification. (Cassar-PTT)
W90-04761

BIODEGRADATION AND REMOVAL OF PHENOLS IN ROTATING BIOLOGICAL CONTACTORS.

New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering. R. Y. Tokuz.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1751-1754, 1989. 3 fig, 4 tab. National Science Foundation Grant ECE-8512733.

Descriptors: *Wastewater treatment, *Phenols, *Activated sludge process, Biofilms, Adsorption, Rotating biological contactors, Biological wastewater treatment, Biodegradation, Pilot plants, Nitrophenols, Chlorophenol.

A pilot-scale rotating biological contactor was allowed to operate on a synthetic wastewater for three months, after which the biodegradability of phenol compounds was tested. 2-Nitrophenol did not affect the system performance adversely; COD removal rates above 90% were obtained in the presence of about 11 mg/l of this compound. Removal of 2-nitrophenol generally was >90%. 2-Chlorophenol did not affect the system performance adversely; COD removal rates above 85% were obtained in the presence of about 3 mg/l of this compound. However, 2-chlorophenol was only partially biodegraded. Removal rates were generally <50%, sometimes as low as 5 to 8%. (Cassar-PTT)
W90-04762

ADVANCED WASTEWATER TREATMENT USING AN IMMOBILIZED MICROORGANISM/BIOFILM TWO-STEP PROCESS.

National Inst. for Environmental Studies, Tsukuba (Japan).
Y. Inamori, K. Matsugie, R. Sudo, K. Chiba, and H. Kikuchi.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1755-1758, 1989. 2 fig, 1 tab, 6 ref.

Descriptors: *Wastewater treatment, *Biofilms, *Advanced wastewater treatment, Biological wastewater treatment, Bacteria, Microorganisms, Adsorption.

Optimum conditions for advanced wastewater treatment were determined for a two-step system combining an immobilized microorganism reactor

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with a biofilm reactor. The apparatus consisted of an immobilized cell reactor with a volume of 300 ml, packed with 60 g of pellets, and a biofilm reactor with a sedimentation tank and a volume of 1.5 l. The 4-mm long pellets were made by immobilizing activated sludge using acrylamide. The feed was artificial wastewater containing meat extract and peptone. Operation by recirculation of effluent from the biofilm reactor achieved high treatment efficiency even under high loading conditions such as 1.4 kg/cu m/day BOD. When operated under anaerobic conditions, BOD, total organic carbon, and nitrogen levels in the effluent were reduced, high transparency was obtained, and fungal growth on the surface of the pellets was prevented. The combined immobilized cell reactor/biofilm reactor process was markedly more efficient than using the immobilized cell reactor alone. (Cassar-PTT)
W90-04763

CADMIUM DECONTAMINATION OF LIQUID STREAMS BY ARTHROBACTER SPECIES
Consiglio Nazionale delle Ricerche, Rome (Italy). A. Grappelli, J. S. Hard, W. Pietrosanti, U. Tomasi, and L. Campanella.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1759-1762, 1989. 2 fig, 3 tab, 9 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Cadmium, *Heavy metals, *Industrial wastewater, Metals, Biofilms, Microorganisms, Arthrobacter, Adsorption.

Four Arthrobacter strains were prepared for use as biomass in treatment of cadmium-containing wastewater. Cells were incubated in cadmium solution for up to 48 hr. Adsorption of the metal was maximum by 30 min. Estimated removal efficiencies were: A. fluorescens, 80%; A. giacomelloi, 53%; A. globiformis, 46%; and A. viscosus, 20%. (Cassar-PTT)
W90-04764

DETENTION TIME DISTRIBUTION OF SLUDGE IN RECTANGULAR SECONDARY SETTLERS
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 5E.
W90-04765

GRIT-ITS REMOVAL, A NEW IDEA
Southern Water Authority, Brighton (England). N. J. Bennett.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1767-1770, 1989. 1 fig.

Descriptors: *Wastewater treatment, *Sedimentation, *Separation techniques, *Grit chambers, Biological wastewater treatment, Shear, Hydrodynamic separator.

The Hydro-Dynamic separator is used to separate settleable solids from storm water. It has been tested at a sewage treatment plant in Sussex determine its usefulness as a grit separator. The Hydro-Dynamic separator satisfactorily removed low-organic grit from high-flow wastewater without the need for backwashing. At reduced flows, a short period of backwashing prior to degritting produced an acceptably clean grit. The separator augments gravitational effects by moving the liquid in a spiral fashion. A shear zone sets up a coagulating and flocculating effect to promote further separation of the grit. Flow is discharged around a baffle plate to the outlet. (Cassar-PTT)
W90-04766

THICKENING OF SLUDGES BY DISSOLVED AIR FLOTATION
National Inst. for Water Research, Pretoria (South Africa). L. R. J. van Vuuren, and P. J. van der Merwe.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1771-1774, 1989. 4 fig, 1 tab.

Descriptors: *Sludge thickening, *Wastewater treatment, *Flotation, Dissolved air flotation, Biological wastewater treatment, Pilot plants.

The use of a float stabilizer was investigated on the pilot scale and full scale dissolved air flotation process for thickening sludges. The device was a grid made of 2-mm x 150-mm metal strips. The float was highly beneficial for the in situ thickening of the sludge. The rate of float buildup above the water level was about 30 mm per day under the experimental conditions. However, prolonged scraping cycles were necessary in order to allow for sufficient depth of float buildup above the float stabilizer and to allow time for drainage of interstitial water before removal. At a solids concentration of 6-7% after 24 to 48 hr aging time, the separated float had a spadeable consistency. (Cassar-PTT)
W90-04767

MOGDEN DIGESTED SLUDGE-APPROACHES TO IMPROVING DEWATERABILITY
Thames Water Authority, London (England). J. L. Dakers, C. J. Hatton, and P. A. Pearce.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1775-1778, 1989. 1 fig, 2 tab, 2 ref.

Descriptors: *Wastewater treatment, *Sludge drying, *Sludge thickening, *Dewatering, *Sludge disposal, Digestion, Elutriation, Filtration, Aerobic digestion, Anaerobic digestion.

The objectives of a sludge dewatering study were to produce a sludge cake suitable for a range of disposal options and a dry solids content of 28-30%. This involved a 3400 cu m/day operation adjacent to London's Heathrow Airport. Initial dewatering trials indicated that fine particulate material (2 to 80 micrometers) was present, causing poor performance in pressing. Bench scale studies were conducted on sludge digestion variables. Sludge subjected to aerobic treatment before anaerobic digestion required much lower polymer dosages; sludge solids as high as 26% were obtained. Elutriated sludge also showed improved dewaterability. This technique removed fine particulates, ammonia, and other soluble compounds. An elutriation pilot plant was constructed and tested. This plant achieved the required >28% cake solids. (Cassar-PTT)
W90-04768

CHARACTERISTICS OF DEWATERED SLUDGE CAKE
Japan Sewage Works Agency, Toda. Research and Technology Development Div. T. Murakami, and M. Nakao.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1779-1782, 1989. 3 fig, 1 tab.

Descriptors: *Wastewater treatment, *Sludge cake, *Sludge solids, *Dewatering, Chemical properties, Organic matter.

Dewatered sludge cakes from 59 sewage treatment plants in Japan were studied to determine the thermal characteristics, caloric value, moisture content, ignition loss, and elemental composition. Two basic types of cakes were considered: amended with polymer and amended with lime and ferric chloride. The % ignition loss plotted against the higher caloric value produced linear relationships, with a distinct difference between polymer and lime cakes. The digestion process had little effect on the caloric values. Relationships were also developed for carbon, hydrogen, sulfur, oxygen, and nitrogen and ignition loss. (Cassar-PTT)
W90-04769

PROCESSING OF STORM-WATER RUNOFF-FRENCH EXPERIMENTS
Ministere de l'Equipelement, Paris (France). Services Techniques de l'Urbanisme. C. Marte, and Y. Ruperd.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1783-1784, 1989. 4 tab, 5 ref.

Descriptors: *Wastewater treatment, *Urban runoff, *Storm wastewater, *Runoff, Storm runoff, Detention reservoirs, Urban areas, France, Hydrocarbons, Heavy metals, Metals.

Storm water treatment techniques were evaluated in urban France. A constant speed degritter

showed average removal efficiencies of 35% for BOD, 43% for COD, 62% for suspended solids, and 29 to 58% for selected heavy metals. An oil separating basin with concrete stops, installed in urban sewers, showed average removal efficiencies of 33% for BOD, 32% for COD, 21% for suspended solids, 53% for hydrocarbons, and 10 to 12% for selected heavy metals. Roadside storage basins removed 17 to 45% of COD and 26 to 63% of selected heavy metals. Two detention basins appeared more efficient: BOD removal was 87% and 56%; COD 80% and 40%; suspended solids, 90% and 74%; hydrocarbons, 94% and 90%; and selected heavy metals, 63% to 94%. The efficiency of all operations varied sharply from one rainfall event to another. (Cassar-PTT)
W90-04770

RAINFALL TIME SERIES FOR STORM OVERFLOW ASSESSMENT

Water Research Centre, Swindon (England). Swindon Engineering Centre.
For primary bibliographic entry see Field 2B.
W90-04772

REVIEW ON THE DESIGN AND CONSTRUCTION OF A LARGE WASTEWATER TREATMENT PLANT

Defland Water Authority, Delft (Netherlands). J. Helmer, J. Vink, and J. M. Janus.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1801-1804, 1989. 2 fig, 4 tab.

Descriptors: *Wastewater facilities, *Wastewater treatment, *Sludge digestion, *Activated sludge process, *Construction, *Design criteria, The Netherlands, Secondary wastewater treatment, Sedimentation, Biological wastewater treatment, Odor control, Digestion.

Design and construction of a large (1 million population equivalent) wastewater treatment plant in the Netherlands is reviewed. Details of interest include the need for good odor control in a densely populated area, use of the UNOX system to treat the presettled wastewater, the pressure swing adsorption method of oxygen generation, concrete treatment to prevent erosion from carbon dioxide, centrifugal process for sludge thickening, a mesophilic anaerobic sludge digestion process adaptable to a thermophilic process, and underground sedimentation tanks. (Cassar-PTT)
W90-04775

EXPERT SYSTEM AS A TOP LEVEL CONTROLLER FOR ACTIVATED SLUDGE PROCESS

Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering. K. Koskinen.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1809-1812, 1989. 1 fig, 4 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Computers, *Process control, Databases, Biological wastewater treatment, Expert systems, Decision making.

An expert system has been developed to improve process control in a Finnish activated sludge plant. It is designed to be used once a day or in problem situations. The database includes information about on-line measurements, manual laboratory analyses, and heuristically qualified information about visual observations. The version currently in use has over 60 rules and 20 diagnoses. Three main factors cover the stages of the process: sludge age, oxygen uptake rate, and settling velocity of the sludge. These are assigned values for high, optimum, and low states. This provides 27 smaller subunits, which can be visualized as a cube with the optimum of the three parameters in the center. The three verification levels start with on-line information. The second and third levels are visual observation and laboratory analyses. The program guides the user to the optimum solution. (Cassar-PTT)
W90-04777

Waste Treatment Processes—Group 5D

PROBABILISTIC RELIABILITY ANALYSIS FOR BIOLOGICAL WASTEWATER TREATMENT PLANTS.

Artois-Picardie Water Agency, Douai (France). C. Assezat.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1813-1816, 1989. 2 fig, 5 tab.

Descriptors: *Wastewater treatment, *Probabilistic process, *Pollution load, *Activated sludge process, Biological wastewater treatment, Model studies, Mathematical studies, Computer programs, Markov process, Maintenance.

Probabilistic reliability methods were adapted to a wastewater treatment plant for the following purposes: simulation of plant operating conditions, quantification of average plant performance, and evaluation of improvements. Plant operation was simulated with a Markov-type model where each state corresponds to a possible failure mode. Failure modes are identified by applying the Failure Modes and Effects Analysis Procedure and are checked by means of a fault tree analysis. The program for the Douai Plant in France has 35 failure modes; each has a corresponding potential pollution load. The reliability data bank has 50 items of equipment with their corresponding reliability of operation at 90% confidence level as well as the time needed for repair or replacement when a spare is on site and when a spare is unavailable on site. A curve of pollutant load can be generated for any failure. (Cassar-PTT)
W90-04778

BIOLOGICAL TREATMENT OF PAPERMILL WASTEWATER IN AN ACTIVATED SLUDGE CASCADE REACTOR.

Papiertechnische Stiftung fuer Forschung und Ausbildung in Papiererzeugung und -Verarbeitung, Munich (Germany, F.R.). Wasser- und Abwasserforschungsstelle.
C. H. Mobius.

Water Science and Technology WSTED4, Vol 21, No. 12, p 1825-1828, 1989. 3 fig, 1 tab, 2 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Industrial wastewater, *Pulp and paper industry, Bulking sludge, Aeration, Biological wastewater treatment, Cascade reactor.

Operation of an activated sludge aeration cascade reactor in a papermill was studied for 10 months. Bulking sludge was a problem at the beginning. This was caused by operational faults that allowed excess sludge to enter the clarifier, in turn causing anaerobic acidification in the primary settling tank. This problem was solved by adding lime slurry to the aeration tank. Bulking sludge was destroyed when the pH was at least 9.5 for a short time. After the operation was optimized, the sludge volume index was consistently low (100 to 150 ml/g), and the BOD and COD removals were good. (Cassar-PTT)
W90-04781

USE OF CULTURED BACTERIA IN A FULL SCALE BIOLOGICAL SYSTEM TREATING COKE PLANT WASTEWATER.

Inland Steel Industries, East Chicago, IN. New Ventures Dept.
R. R. Landreth.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1829-1832, 1989. 1 fig.

Descriptors: *Wastewater treatment, *Bacteria, *Industrial wastewater, *Coke industry, *Biological wastewater treatment, Coal, Ammonia, Phenols, Thiocyanates, Cyanide, Chemical wastewater.

Addition of cultured bacteria to coke plant wastewater containing ammonia, phenol, thiocyanate, and cyanide greatly increased biomass growth, as evident from the drop in the food/biomass ratio from 0.8 to 0.5 and from the increase in mixed liquor volatile suspended solids from 8140 mg/l to 10,000 mg/l. Two problems developed with the use of the bacteria. The first was nitrogen gas formation in the clarifiers, which caused sludge to rise and pass into the effluent. The second problem was the rapid bacterial consumption of the anti-

foaming agents, resulting in foaming. The cultured bacteria stabilized the operation of the biological treatment system and did improve the removal efficiency of ammonia and thiocyanate. However, the removal efficiencies of phenol and cyanide were not significantly enhanced. (Cassar-PTT)
W90-04782

DETERMINATION OF CELLOSOLVE AND CHLOREX CONCENTRATIONS INHIBITORY TO INDUSTRIAL WASTE STABILIZATION POND TREATMENT EFFICIENCIES.

Texas Univ. Health Science Center at Houston. School of Public Health.
E. M. Davis, E. C. Sullivan, and T. D. Downs.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1833-1836, 1989. 8 fig, 3 tab.

Descriptors: *Biodegradation, *Wastewater treatment, *Industrial wastewater, *Organic compounds, *Stabilization ponds, Ponds, Cellosolve, Chlorex, Bischloroethyl ether, Ethoxyethanol, Chemical wastewater, Toxicity.

The concentrations of Cellosolve (2-ethoxyethanol) and Chlorex (bis (2-chloroethyl)ether) inhibitory to biodegradation were determined for each of three stabilization ponds which are used in series to treat wastewater from a chemicals and plastics plant. Respirometric BOD tests were used to evaluate the effects of varying doses of the chemicals. Cellosolve caused significant inhibition of overall degradation in the wastewaters at and above 1000 mg/l. Chlorex was more inhibitory. Decreases in biodegradation activity occurred in all wastewater tested at and above 300 mg/l. A lag period of up to two days was present before oxygen uptake occurred. This suggested that the microbial populations were responding to the chemical additions by acclimation before their normal respiration/degradation activity could proceed. (See also W90-04784) (Cassar-PTT)
W90-04783

BIS(2-CHLOROETHYL)ETHER AND 2-ETHOXYETHANOL TREATABILITY AND TOXICITY IN LAB SCALE WASTE STABILIZATION PONDS.

Texas Univ. Health Science Center at Houston. G. D. Ramey, and E. M. Davis.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1837-1840, 1989. 4 fig, 1 tab.

Descriptors: *Biodegradation, *Wastewater treatment, *Industrial wastewater, *Organic compounds, *Stabilization ponds, Ponds, Cellosolve, Chlorex, Bischloroethyl ether, Ethoxyethanol, Chemical wastewater, Toxicity.

Three model waste stabilization ponds were constructed in series to study the treatment system handling Cellosolve (2-ethoxyethanol) and Chlorex (bis(2-chloroethyl)ether) wastes. The primary model pond was characterized by anaerobic fermentation of feed hydrocarbons to organic acid products. No obvious fermentation inhibition was evident even at the highest Cellosolve feed concentration of 8000 mg/l. The secondary model pond was characterized by degradation of the diluted organic acids in the feed with a slight pH increase from inlet to outlet. Visible biomass changes occurred at the highest Cellosolve feed levels (1000 mg/l). The tertiary model pond had a large algal population. Cellosolve was almost totally degraded at all feed concentrations. Adverse changes in the biological system occurred at the 500 and 1000 mg/l Cellosolve feed levels, and Cellosolve breakdown products appeared in the effluent. The biological systems showed obviously adverse responses at Cellosolve feed levels of 500 and 1000 mg/l. However, recovery was rapid when the level of Cellosolve was reduced to 10 mg/l. No apparent adverse responses to the Chlorex 10 mg/l feed were observed in any of the ponds. (See also W90-04783) (Cassar-PTT)
W90-04784

TREATMENT OF WASTEWATERS FROM SUGAR CANE ALCOHOL PRODUCTION WITH MODIFIED BENTONITES.

Sao Paulo Univ. (Brazil). Dept. of Chemical Engineering.

P. M. Buchler.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1845-1847, 1989. 10 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Alcohols, *Sugarcane, *Fermentation, Bentonite, Clays, Adsorption, Vinasse, Organic matter, Activated carbon.

Two bentonites modified with tetramethylammonium chloride were tested as adsorption media for the constituents of waste from sugar cane alcohol production. The synthetic wastewater solution contained glycerol, ethanol, glucose, fructose, phenol, dextran, and glycine. Phenol was strongly adsorbed by the modified bentonites. Other components were adsorbed to a lesser extent. (Cassar-PTT)
W90-04786

INVESTIGATION OF AN INNOVATIVE TECHNOLOGY FOR OIL-FIELD BRINE TREATMENT.

Novi Sad Univ. (Yugoslavia). Faculty of Science. D. Miskovic, B. Dalmacija, Z. Hain, E. Karlovic, and S. Maric.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1849-1852, 1989. 1 fig, 3 tab, 6 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Activated sludge process, *Brines, *Oil fields, Biological wastewater treatment, Sedimentation, Advanced wastewater treatment, Activated carbon, Adsorption, Secondary wastewater treatment, Laboratory methods.

A scheme for complete treatment of oil-field brine was investigated on a laboratory scale. The influent contained 29,322-34,654 g/cu dm of salt, 138.5-314.8 mg/cu dm of oil, an organic concentration of 940-2530 mg KMnO₄/cu dm, and hard-to-biodegrade materials (BOD/COD = 0.25 to 0.30). The primary treatment involved gravitational separation of oil for 30 hr, coagulation and flocculation with added ferric chloride, alum, and lime, followed by primary sedimentation with production of small amounts of inorganic sludge. The secondary treatment involved microbiological treatment with 25% dilution with fresh water and the addition of powdered activated carbon. Advanced treatment was carried out using granular activated carbon. BOD values in the final effluent were 0.2-15 mg oxygen/cu dm. (Cassar-PTT)
W90-04787

PRODUCTION OF PROTEIN FOR ANIMAL FEED STUFF USING ORGANIC WASTEWATERS FROM WINE DISTILLERIES.

Forschungsinstitut fuer Wassertechnologie e.V., Aachen (Germany, F.R.).
C. Wetter, K. Poeppinghaus, H. Morais, M. Dias, and B. Mendez.

Water Science and Technology WSTED4, Vol 21, No. 12, p 1853-1856, 1989. 1 fig, 5 tab, 8 ref.

Descriptors: *Sludge utilization, *Wastewater treatment, *Activated sludge process, *Industrial wastewater, Wine industry, Animal feed, Biological wastewater treatment, Proteins.

Wastewater produced from distillation of excess and poor quality red wines (COD of 26,528-30,040 mg/l and BOD of 6000-10,720 mg/l) was treated in a pilot plant activated sludge process which produced a sludge suitable for animal feed (37% raw protein). The treatment process featured primary sedimentation, aeration, and final sedimentation. Nutrient supplementation with ammonium sulfate and calcium phosphate improved biodegradation. The efficiency of waste treatment was about 90%, and the biomass production was 7.5 g/l. (Cassar-PTT)
W90-04788

ANAEROBIC TREATMENT OF CHEESE WHEY. START-UP AND OPERATION.

Santiago Univ. (Spain). Dept. of Chemical Engi-

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

neering.

R. Mendez, R. Blazquez, F. Lorenzo, and J. M. Lema.

Water Science and Technology WSTED4, Vol 21, No. 12, p 1857-1860, 1989. 3 fig, 4 tab, 6 ref. Spanish CAICYT Contract PR84-0466.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Whey, *Food-processing wastes, *Anaerobic digestion, Biological wastewater treatment, Digestion, Dairy industry.

Three waste streams from a dairy products factory were characterized and considered in a wastewater treatment plan. Treatment of the stream responsible for 15% of the overall flow, but with the highest concentration of pollutants, eliminated 82% of the total COD. Treatment of this concentrated stream together with a moderately concentrated stream (together 30% of flow) eliminated 97% of the total organic load. Wastewater was treated in an upflow anaerobic reactor. (Cassar-PTT) W90-04789

ANAEROBIC/AEROBIC TREATMENT OF PIGGERY AND CHEESE-DAIRY WASTEWATER-A CASE STUDY.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forêts, Lyon (France).

J. B. le Hy, B. Montuelle, and J. Coillard.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1861-1864, 1989. 1 fig, 4 tab, 5 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Food-processing wastes, *Dairy industry, *Animal wastes, Biological wastewater treatment, Anaerobic digestion, Aerobic conditions, Activated sludge process, Digestion, Hogs.

Increased production of a piggery operation and a dairy industry necessitated expansion of the wastewater treatment facilities handling pig stall slurry and washing water from cheese production. The chosen design included an anaerobic stage for initial treatment of the pig slurry followed by a thickener before introduction into the aerobic stage. The anaerobic step reduced the total COD in the pig slurry by 66%; the suspended solids by 39%, the volatile solids by 48%, and the total phosphorus by 30%. Use of biogas from the reactor reduced propane use in the plant by 26%. Removal efficiencies, considering the total operation, were as follows: COD, 98%; BOD, 99.4%; nitrogen, 96%; phosphorus, 93%; and suspended solids, 99%. Problems remaining in the system include leaks in the pig slurry collection system which bypass the anaerobic reactor, hair deposits in the coil heat exchanger and digested slurry pipe, and the near-capacity operation of the aerobic stage, which cannot cope with overloads. (Cassar-PTT) W90-04790

COMPUTER PROGRAM FOR FARM WASTE MANAGEMENT.

West of Scotland Agricultural Coll., Auchincruive, Dept. of Microbiology.
I. F. Svoboda.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1865-1868, 1989. 5 tab, 2 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Waste management, *Waste disposal, *Farm wastes, *Land disposal, *Computer programs, Animal wastes, Nutrients, Hogs, Anaerobic digestion, Digestion, Biological treatment, Aerobic conditions.

A computer program provides a plan for management of farm wastes. It has five subprograms: estimation of quantity and characteristics of raw wastes, mechanical separation of raw wastes, aerobic treatment, anaerobic treatment and land spreading. The case of a piggery slurry is given as an example. Mechanical separation allows composting of solids, with the remaining liquid used for irrigation or further treatment. Aerobic treatment can reduce odors and pollutant concentrations. Anaerobic treatment can be done in a lagoon

or tank, and biogas may be collected if desired. Land application rates and suggestions for adding deficient nutrients for various crops (e.g. for silage) are given. (Cassar-PTT) W90-04791

AMOUNT OF HEAVY METALS DERIVED FROM DOMESTIC WASTEWATER.

Yokosuka City Sewage Works Div. (Japan).
For primary bibliographic entry see Field 5B. W90-04802

BIOMASS, AND NITROGEN, PHOSPHORUS, AND HEAVY METAL CONTENT OF PHRAGMITES AUSTRALIS DURING THE THIRD GROWING SEASON IN A ROOT ZONE WASTE WATER TREATMENT.

Arizona State Univ., Tempe. Dept. of Botany and Microbiology.
C. Gries, and D. Garbe.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 1, p 97-105, November 1989. 2 fig, 1 tab, 37 ref.

Descriptors: *Aquatic plants, *Root zone wastewater treatment, *Grasses, *Biological wastewater treatment, *Land disposal, *Wastewater treatment, *Nutrients, *Heavy metals, *Bioaccumulation, Phragmites, Zinc, Cadmium, Iron, Lead, Copper, Chromium, Biomass, Germany, Nitrogen, Phosphorus.

For Phragmites australis growing in a root zone wastewater treatment in Northern Germany biomass, ion uptake and distribution within the plant were investigated. High stalk density (150-200/sq m), low stand height (stalk length 180 cm s.d. +/- 50) and a small root mass per unit rhizome were related to the high nutrient supply. The accumulation of phosphate, zinc, cadmium, iron and lead was very high in the roots; however, concentrations in the shoots and rhizomes were even lower than in reed grown in natural habitats. Nitrogen content was independent of the high ammonia supply. Only copper and chromium were transported into the shoot in higher amounts than in habitats with lower background concentrations of these elements. (Author's abstract) W90-04809

SPECIFICITY OF THE DPD AND AMPEROMETRIC TITRATION METHODS FOR FREE AVAILABLE CHLORINE: A REVIEW.

State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F. W90-04812

TREATMENT OF RAW DOMESTIC SEWAGE IN AN UASB REACTOR.

Universidade Federal do Rio de Janeiro (Brazil). Coordenacao dos Programas de Pos-graduacao de Engenharia.
R. A. Barbosa, and G. L. Sant'Anna.
Water Research WATRAG, Vol. 23, No. 12, p 1483-1490, December 1989. 6 fig, 5 tab, 17 ref.

Descriptors: *Activated sludge process, *Wastewater reactors, *Wastewater treatment, *Raw wastewater, *Anaerobic digestion, *Domestic wastes, *Biological wastewater treatment, Upflow anaerobic sludge bed reactor, Biodegradation, Biological oxygen demand, Chemical oxygen demand, Methane, Suspended solids.

The treatment of raw domestic sewage at ambient temperatures in an upflow anaerobic sludge blanket (UASB) reactor with a volume of 120 L and a height of 1.92 meters was studied. The sewage had an average BOD₅ of 357 mg/L and COD of 627 mg/L. Approximately 75% of the organic materials were in the suspended fraction. The sewage temperature ranged from 18 to 28 °C during the experimental period. The reactor operated continuously for 9 months and assessed self-inoculation and raw domestic sewage purification. The unit was started without inoculum and ran during the entire experimental period with a hydraulic retention time of 4 hours. During the experiment, a

sludge bed build-up was observed. At the end of the experimental period, the predominance of spherical granular particles up to 6 to 8 mm in diameter was evident. After a 4-month operation, it was observed that the inoculation/acclimatization steps had been concluded. Removal efficiencies of BOD₅ = 78%, COD = 74% and TSS = 72% were obtained. A typical gas production factor of 80 L/kg COD added was observed and the methane content of the biogas was 69%. (Author's abstract) W90-04835

APPROXIMATE ALGEBRAIC SOLUTION FOR A BIOFILM MODEL WITH THE MONOD KINETIC EXPRESSION.

General Motors Research Labs., Warren, MI. Environmental Science Dept.
B. R. Kim, and M. T. Suidan.
Water Research WATRAG, Vol. 23, No. 12, p 1491-1498, December 1989. 5 fig, 1 tab, 14 ref.

Descriptors: *Mathematical models, *Biofilms, *Biological filters, *Biological wastewater treatment, *Wastewater treatment, *Biofilm reactors, *Kinetics, *Microbial degradation, Approximation method, Monod kinetics, Substrates.

A steady-state biofilm model, which describes attached-biofilm reactors, is often derived by simultaneously considering microbial kinetics and diffusion through a biofilm. When Monod kinetics is used to describe the microbial kinetics in the biofilm, the resulting equation becomes analytically insoluble. In this paper, an approximate solution, having an explicit algebraic form, was developed using the orthogonal collocation method to relate the steady-state substrate flux into the biofilm to the bulk substrate concentration, and to predict the effluent substrate concentration from a continuous stirred-tank reactor. The accuracy of the approximate solution was evaluated by comparing the solution to an accurate numerical solution. The comparison indicated that the approximate solution is very accurate for the case in which the substrate fully penetrates the biofilm (i.e. a shallow biofilm), and is inaccurate for the case in which the substrate partially penetrates the biofilm (i.e. a deep biofilm). The accuracy was found to depend upon biofilm thickness and substrate concentration in the bulk liquid. In addition, the region in which the approximate solution was accurate was graphically developed along with the regions of three limiting cases (i.e. zero-order, first-order and deep biofilm). These regions graphically illustrate where the approximate solution and each limiting case are valid in a two-dimensional space of substrate concentration and biofilm thickness. (Author's abstract) W90-04836

EFFECT OF WASTEWATER SPRAY IRRIGATION ON ROTAVIRUS INFECTION RATES IN AN EXPOSED POPULATION.

James N. Gamble Inst. of Medical Research, Cincinnati, OH.
R. L. Ward, D. R. Knowlton, J. Stober, W. Jakubowski, and T. Mills.
Water Research WATRAG, Vol. 23, No. 12, p 1503-1509, December 1989. 6 tab, 28 ref. US EPA Assistance Agreement CR 813084.

Descriptors: *Rotaviruses, *Public health, *Human pathology, *Population exposure, *Wastewater irrigation, *Viruses, *Spray irrigation, Wastewater disposal, Infection, Blood, Bioassay, Immunoassay, Texas.

The Lubbock Infection Surveillance Study was conducted between June 1980 and October 1983 to detect potential increases in enteric infection and disease incidence in a community surrounding a wastewater spray irrigation site. A 25 km pipeline transported an average daily flow of 14,000 cu m of trickling filter effluent from the Lubbock (Texas) Sewage Treatment Plant to a 1500 ha farm directly from both the pipeline and storage reservoirs. Operation commenced in February 1982 and irrigation was conducted primarily by 22 center-pivot sprinklers. This report concerns the incidence of rotavirus infections in study participants

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during that period. Rotavirus infection was defined as a greater than 2-fold increase in rotavirus serum antibody between blood collections which occurred approximately every 6 months. Antibody was detected by an enzyme-linked immunosorbent assay (ELISA). Of the 368 participants who provided 2 or more blood specimens, 67 seroconversions to rotavirus were detected, an average annual rate of 6.8 infections per 100 subjects. One subject was infected twice. Seroconversions were observed in 32.7% (32/98) of children (16 years of age or younger) and in 12.7% (33/260) of adults (17 years or older) with a single infection. Thus, significantly more ($P < 0.0001$) rotavirus infections occurred in children. Baseline rotavirus serum antibody titers were found to be significantly lower ($P = 0.047$) in subjects who seroconverted. However, many children and adults with high titers were also infected. More seroconversions were observed between June and December (January) than between December (January) and June. Wastewater spray irrigation had no detectable effect on the incidence of rotavirus infection. (Author's abstract)
W90-04838

EFFECT OF REACTOR HYDRAULICS ON THE PERFORMANCE OF ACTIVATED SLUDGE SYSTEMS: I. THE TRADITIONAL MODELLING APPROACH.

Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
D. Orhon, S. Soybay, O. Tunay, and N. Artan.
Water Research WATRAG, Vol. 23, No. 12, p 1511-1518, December 1989. 4 fig, 3 tab, 23 ref.

Descriptors: *Wastewater reactors, *Wastewater treatment, *Activated sludge process, *Biological wastewater treatment, *Mathematical models, *Model studies, Kinetics, Monod kinetics, Chemical oxygen demand, Performance evaluation, Hydraulic, Substrates, Biomass, Growth kinetics, Microbial degradation, Plug flow.

The traditional modeling approach involving only overall substrate and biomass parameters and a Monod-type rate expression was used to investigate the effect of reactor hydraulics on the substrate removal efficiencies of activated sludge systems. The traditional kinetics was observed to give a useful, although not completely accurate picture of performances of different types of reactors: it showed basically that the relative performance of a given hydraulic configuration was significantly affected by the kinetic constants as well as by operating parameters. The results of model simulations indicated that most experimental studies in this area, were designed to operate at a range which should secure complete removal of the growth limiting substrate; therefore, the related experimental data so far available, do not necessarily provide conclusive evidence on the effect of reactor hydraulics. The reported effluent substrate levels, identified in terms of an overall parameter such as COD, appear to be much higher than what may be derived from a kinetic evaluation for both a completely mixed (CSTR) and a plug flow reactor (PFR), possibly indicating the presence of soluble microbial products. (See also W90-04840) (Author's abstract)
W90-04839

EFFECT OF REACTOR HYDRAULICS ON THE PERFORMANCE OF ACTIVATED SLUDGE SYSTEMS: II. THE FORMATION OF MICROBIAL PRODUCTS.

Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
N. Artan, and D. Orhon.
Water Research WATRAG, Vol. 23, No. 12, p 1519-1525, December 1989. 7 fig, 5 tab, 16 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Hydraulics, *Wastewater reactors, *Metabolites, *Wastewater treatment, *Mathematical models, *Kinetics, *Microbial degradation, Simulation, Model studies, Substrates, Performance evaluation, Biomass, Growth kinetics, Plug flow.

A new model involving the concept of soluble residual microbial products formation was used to

investigate the effect of reactor hydraulics on the substrate removal efficiencies of activated sludge systems. Strong experimental evidence in the literature suggests that what is measured in most studies is not the remaining portion of the influent degradable substrate, but organic matter of microbial origin which is residual, at least for the operating conditions considered. An appropriate simulation approach was formulated to account for the formation of these products, by a simple mechanistic modification of the newly proposed task group model. This model showed no practical difference between the performances of completely mixed and plug flow activated sludge systems, because they produced almost equal amounts of these microbial products, under similar operating conditions. (See also W90-04839) (Author's abstract)
W90-04840

SIMPLE, CONCEPTUAL MATHEMATICAL MODEL FOR THE ACTIVATED SLUDGE PROCESS AND ITS VARIANTS.

North Carolina State Univ. at Raleigh. Dept. of Chemical Engineering.
N. Padukone, and G. F. Andrews.
Water Research WATRAG, Vol. 23, No. 12, p 1535-1543, December 1989. 4 fig, 29 ref.

Descriptors: *Kinetics, *Activated sludge process, *Contact stabilization, *Biological wastewater treatment, *Wastewater treatment, *Mathematical models, Growth kinetics, Flocculation, Model studies.

A simple structured kinetic model is applied to the activated sludge process. The objective is less to predict exact process performance than to illustrate some of the possibilities and difficulties in producing a comprehensive model for all the process variants. The rate equations are chosen so as to reduce to the Monod equation during balanced growth. Because these rate equations are linear, the cell growth and substrate uptake in a stirred tank can be defined exactly in terms of the average composition of the biomass. It is shown that this is not valid for other forms of rate equations. The stored substrate to protoplasm ratio in the flocs is found to decrease with increasing mean cell residence time. If extracellular biopolymers are included in the stored substrate, this corresponds qualitatively to observations of poor flocculation in extended aeration. The model is also applied to the contact stabilization process and is found to be in agreement with the essential process variables. This kinetic model is believed to be the simplest model capable of giving a realistic description of the contact stabilization process. (Author's abstract)
W90-04842

AUTOMATIC SAMPLING EQUIPMENT AND BOD TEST NITRIFICATION.

Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
B. Koopman, C. M. Stevens, C. L. Logue, P. Karney, and G. Bitton.
Water Research WATRAG, Vol. 23, No. 12, p 1555-1561, December 1989. 5 fig, 1 tab, 11 ref.

Descriptors: *Wastewater treatment, *Biochemical oxygen demand, *Water sampling, *Activated sludge process, *Nitrification, *Wastewater facilities, Nitrogen fixing bacteria, Florida, Automation, Biological membranes.

At the Buckman and Southwest wastewater treatment plants in Jacksonville, FL, which are non-nitrifying activated sludge facilities, problems were encountered with high BOD₅s in flow-composited effluent samples during periods when effluent suspended solids were low and biological upsets were absent. It was hypothesized that the source of nitrifying bacterial seed was the automatic sampling equipment in place at the facilities. This study was carried out to determine the cause of nitrification and evaluate the influence of alternate sampling equipment on BOD₅ measurements. Samples were tested for BOD, carbonaceous BOD, nitrogenous oxygen demand and concentration of nitrifying bacteria. Biofilms inside the equipment were tested for nitrification potential. A sampler

utilizing continuous circulation of final effluent was found to support attached growth of nitrifying bacteria and was associated with relatively high effluent nitrogenous oxygen demand. The effluent nitrogenous oxygen demand and nitrification potential of attached growth were significantly less with a unit that aspirated effluent on an intermittent basis, purging the sample line with air before and after sampling. Peak nitrifier counts in samples from the continuous flow equipment exceeded those in samples from the intermittent flow equipment. Given the common use of the continuous-flow sampling equipment, it would appear that BOD test nitrification problems at many non-nitrifying facilities could be ameliorated simply by switching to intermittent-flow equipment. (Ver- Nooy-PTT)
W90-04844

ZN SOLUBILITY IN LOW CARBONATE SOLUTIONS.

National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 2K.
W90-04845

IN SITU CONTROL OF SULFIDE EMISSIONS DURING THE THERMOPHILIC (55 °C) ANAEROBIC DIGESTION PROCESS.

Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
M. J. McFarland, and W. J. Jewell.
Water Research WATRAG, Vol. 23, No. 12, p 1571-1577, December 1989. 5 fig, 5 tab, 19 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Sulfides, *Emission control, *Wastewater treatment, *Sulfur bacteria, *Thermophilic bacteria, Chemical reduction, Sulfates, Hydrogen ion concentration, Iron compounds, Phosphates, Methane.

Sulfate in an anaerobic digester may be reduced rapidly to sulfide by sulfate reducing bacteria which utilize sulfate as the terminal electron acceptor during organic matter metabolism. Sulfide volatilization was found to be sensitive to the pH variations expected during normal anaerobic digester operation. As digester pH levels increased from 6.7 to 8.2, gaseous sulfide concentrations decreased from 2900 to 100 ppm H₂S(g). Although gaseous sulfide control through pH adjustment was technically feasible, its practical use was limited by the resulting increase in soluble sulfide concentration. pH adjustment for biogas sulfide control was recommended only under conditions in which the influent sulfur level was well below sulfide inhibitory concentrations. Control of gaseous sulfide levels through insoluble iron(++) phosphate addition was an efficient gaseous sulfide control process with no adverse effects on digester performance. By varying the influent FePO₄-FeSO₄(-)-S input ratio from 0.0 to 3.5, gaseous sulfide levels decreased from 2400 to 100 ppm. The availability of iron under anaerobic conditions from an aerobically insoluble compound has been termed reductive solubilization. Using results from this investigation, a unique anaerobic digestion system is outlined to treat sulfur rich wastes in which sulfide inhibition is minimized while maximizing energy recovery. (Author's abstract)
W90-04846

ROLE OF FORMATE IN THE ANAEROBIC BAFFLED REACTOR.

Imperial Coll. of Science and Technology, London (England). Dept. of Chemical Engineering and Chemical Technology.

A. Grobicki, and D. C. Stuckey.
Water Research WATRAG, Vol. 23, No. 12, p 1599-1602, December 1989. 8 fig, 13 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Biological wastewater treatment, *Fermentation, *Formates, *Baffles, Wastewater facilities, Methane, Shock loads, Chemical oxygen demand.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

Formic acid has been known for many years to be produced by mixed cultures during anaerobic fermentation. The experimental data from pseudo-steady state runs show that formate will only be detected at steady state if the stages of the process are segregated. In continuously stirred tank reactors (CSTRs), formate may exist below the K_{sub} of formate-utilizing methanogens (5 mg/L or less). In the experimental anaerobic baffled reactor (ABR), which is essentially a series of CSTRs, unusual conditions prevailed in the first few compartments, partially de-linking the fermentative and methanogenic stages. This allowed a build-up of formate to be seen in the first two or three compartments, that quickly disappeared in the later compartments. Under conditions of shock loading, formate was detected in the reactor effluent, up to peak concentrations of 2500 mg/L. This was followed by a rapid recovery of the reactor to 99% COD removal, indicating unusual stability. (Author's abstract)
W90-04849

CULTURE OF CYANOBACTERIA FOR TERTIARY WASTEWATER TREATMENT AND BIOMASS PRODUCTION.
Bionov CNP, Inc., Quebec (Canada).
Y. Pouliot, G. Buelna, C. Racine, and J. de la Noue.
Biological Wastes BIWAED, Vol. 29, No. 2, p 81-91, 1989. 11 fig, 25 ref.

Descriptors: *Biological wastewater treatment, *Tertiary wastewater treatment, *Wastewater treatment, Algae, Cyanophyta, Nitrates, Culturing techniques, Chlorella, Dissolved oxygen.

In order to determine factors influencing the treatment efficiency of wastewater by culture of cyanobacteria, experiments were conducted at laboratory scale on the effect of different aeration-agitation modes (stirring and air bubbling) on treatment efficiency, growth rate and occurrence of grazers and Chlorella-like cells. Nitrate addition and dissolved oxygen were also studied. The best aeration-agitation mode, according to treatment efficiency and growth rate, was the culture bubbled on a 14/24 h basis: ammonia and phosphate removal were 95 and 62%, respectively (for a treatment time of one day), and growth was 0.34 per day. Stirring bars did not appear to be a suitable system to agitate filamentous cyanobacterial cultures because of the low culture aeration, the occurrence of nitrification and the breakage of algal cells. This last effect appeared to explain the low level of grazer population. Populations of Chlorella-like cells remained relatively low in both aeration-agitation modes. Dissolved oxygen did not have a marked effect on grazer population. Addition of inorganic nitrate to senescent cultures markedly improved the health condition of cyanobacteria cultures. (Author's abstract)
W90-04860

THERMOPHILIC PROCESS FOR PROTEIN RECOVERY AS AN ALTERNATIVE TO SLAUGHTERHOUSE WASTEWATER TREATMENT.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
S. Garipey, R. D. Tyagi, D. Couillard, and F. Tran.
Biological Wastes BIWAED, Vol. 29, No. 2, p 93-105, 1989. 1 fig, 7 tab, 26 ref.

Descriptors: *Waste utilization, *Wastewater treatment, *Industrial wastes, *Food processing industry, Thermophilic treatment, Bioreactors, Chemical oxygen demand, Amino acids.

Research was conducted to investigate the quantitative and practical aspects related to the utilization of an aerobic thermophilic process to process a typical effluent of the meat industry (a pig slaughterhouse effluent). This process is particularly suitable for effluents discharged at high or warm temperatures (30-70°C). Thermophilic treatment of the waste was carried out in a laboratory bioreactor at different temperatures and solids retention times without cell recycle. COD was reduced by over 93%. Phosphorus was removed from 72 to

90% under different cultivation conditions. A high rate of specific substrate consumption was observed compared to that obtained in mesophilic processes. The composition of the essential amino acids in the biomass was similar to that of meat and soya meals and appeared well-balanced and appropriate for pigs and poultry feeding. (White-Reimer-PTT)
W90-04861

ROTATING BIOLOGICAL EXTENDED CONTACTOR.
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Water Chemistry and Waste Treatment.
M. Krzemieniewski.
Biological Wastes BIWAED, Vol. 29, No. 4, p 271-277, 1989. 6 fig, 7 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Biological contactors, Chemical oxygen demand, Secondary wastewater treatment, Hydraulic loading, Flow.

In order to eliminate the negative effects of variations in sewage quantity on the effectiveness of treatment using a rotating biological contactor (RBC), a rotating biological extended contactor (RBEC) was constructed. Flow rate varied from 8 L/d to 160 L/d, while waste concentration, in COD, was from 3000 mg O₂/L to 120-150 mg O₂/L. Results of the RBEC were compared with those of a RBC. The COD reduction in the conventional contactor (RBC) was 82% compared with 92% reduction in the extended reactor (RBEC) at the same hydraulic loading of 0.013 cu m/sq m/d. On the other hand, at loading levels of 0.1 cu m/sq m/d in the RBC reduction amounted to 48%, while the RBEC reduced waste COD concentration by 82%. The effectiveness of the treatment depended on the amount of suspended biomass solids in the waste container, but with high concentration of suspended biomass oxygen deficits were likely to occur. Reduction of the concentration of the suspension might be attained by recirculating the treated wastes. Just as with conventional rotating biological contactors the extended ones can be coupled, with container and drive shaft divisions. If the container is in the form of a cylinder with a flat bottom, the positioning of the waste inflow and of treated water discharge is very important. Sewage should reach the inner section of the container, while the discharge should be from the outer section. (White-Reimer-PTT)
W90-04863

BIOLOGICAL TREATMENT OF A PHARMACEUTICAL WASTEWATER.
National Univ. of Singapore. Dept. of Civil Engineering.
W. J. Ng, M. G. S. Yap, and M. Sivasdas.
Biological Wastes BIWAED, Vol. 29, No. 4, p 299-311, 1989. 6 fig, 2 tab, 18 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Industrial wastewater, Pharmaceutical wastes, Chemical oxygen demand, Biological oxygen demand, Aeration, Clarifiers, Anaerobic conditions.

The treatability of a pharmaceutical wastewater using a two-stage biological system was investigated. The system consisted of two reactors operated in a batchwise mode with the effluent of reactor A becoming the feed for reactor B. During a cycle of operation each reactor served, in turn, as the aeration basin and then the clarifier. Results indicated that a wastewater with a chemical oxygen demand (COD) of about 26,500 mg/L and 5-day biological oxygen demand (BOD₅) of about 12,500 mg/L could be treated with the system. COD removal by reactor A ranged from 96 to 63% while system COD removal ranged from 99 to 86% as various loading conditions were investigated. It was initially thought that the 2-ethylhexanoic acid present in the wastewater at a concentration of 2500 mg/L might prove inhibitory to the biological process and adversely affect treatment performance. The system, however, adapted well and the 2-ethylhexanoic acid was effectively removed. Gas chromatographic analysis of reactor A's effluent suggested

the occurrence of fermentation. Ethanoic, propanoic, butanoic and, on one occasion, pentanoic acids were detected. These were originally absent in the wastewater. The results suggested that the system might be further developed on the lines of the sequencing batch reactor (SBR) concept. In comparison to the conventional effluent treatment plant configuration comprised of trickling biofilter, activated sludge basins, secondary clarifiers and sludge return, the two-stage batch system would probably be simpler in terms of construction, operation and maintenance. (Author's abstract)
W90-04864

EFFECT OF HIGH SULFITE CONTENTS ON ANAEROBIC DIGESTION OF RAISIN-FINISHING WASTEWATER.
Patras Univ. (Greece). Dept. of Chemistry.
N. Athanassopoulos, J. Kouinis, A. Papakimitriou, and A. A. Koutinas.
Biological Wastes BIWAED, Vol. 30, No. 1, p 53-60, 1989. 4 fig, 1 tab, 8 ref.

Descriptors: *Anaerobic digestion, *Sulfites, *Food-processing wastes, *Wastewater treatment, *Biological wastewater treatment, Upflow anaerobic sludge bed reactor, Chemical oxygen demand, Organic loading.

When treating raisin-finishing wastewater in an upflow anaerobic sludge bed reactor (UASB), no significant inhibition was observed using feeds with unusually high sulfite contents (5,000-9,000 mg/L), when the COD concentrations were 38,000-43,000 mg/L. In addition, relatively high undissociated hydrogen sulfide concentrations (close to 200 mg/L) were not an inhibitory factor in COD removal efficiency. Sulfides resulted in a reduction of methane in the biogas. Higher methane concentrations were obtained with relatively average COD and sulfite contents. The toxicity related to the COD (SO₃(2-)-S) ratio was lower at the largest COD values of the influent used (38,000-43,000 mg/L) than a smaller (7,000-14,000 mg/L), at similar COD (SO₃(2-)-S) ratios of 19-30. The high sulfite content of the raisin-finishing wastewater as well as the very high sulfite concentration sometimes obtained in the production operation, does not inhibit its anaerobic treatment in a UASB reactor; the resistance of anaerobic digestion bacteria to high sulfite content is correlated with the organic load (invert sugar content) in the influent; the percentage of reduction of sulfites is increased at high concentrations of organic matter. (Author's abstract)
W90-04865

COMPUTER OPTIMIZATION OF THE PERFORMANCE OF AN ANAEROBIC FILTER USED FOR PURIFICATION OF HIGHLY POLLUTED WASTEWATER FROM A SUGAR REFINERY.
Zurich Univ. (Switzerland). Inst. of Plant Biology.
E. DaPra, K. Schneider, and R. Bachofen.
Experientia EXPEAM, Vol. 45, No. 11/12 p 1024-1029, December 1989. 8 fig, 12 ref.

Descriptors: *Wastewater treatment, *Anaerobic filters, *Food-processing wastes, *Computers, Chemical oxygen demand, Organic matter, Sugar refineries, Pilot studies, Computer models.

An anaerobic filter system with a volume of 11 L fed with wastewater from the Swiss sugar refinery in Frauenfeld was established on a laboratory scale. It provided a filter performance of over 8 kg COD/cu m/d with an efficiency of at least 70%. A 600 L pilot plant system in the factory gave a degradation efficiency of 70% when fed with 28 kg COD/cu m/d and yielded 0.34 cu m methane/kg COD, demonstrating that the scaling-up of the anaerobic filter had been successful. The rapidly-varying concentrations of organic materials in the wastewater required the constant control of the wastewater flow to the system. A control program was developed for a small computer using an empirical model simulating the operator. By varying the influent rate of the wastewater to the anaerobic filter the computer kept the system at an optimal organic load. The results obtained were equivalent

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to those obtained by permanent control of the system by an operator. (Author's abstract)
W90-04867

MALFUNCTIONING TREATMENT WORKS: LIABILITY AND LEGAL REMEDIES.
Wickwire Gavin, Madison, WI.
R. J. Smith, and J. K. Holland.
Water Environment and Technology, Vol. 1, No. 2, p 298-305, October 1989. 3 fig.

Descriptors: *Wastewater facilities, *Municipal wastewater, *Wastewater treatment, Design standards, Contracts, Legal aspects.

When a water or wastewater treatment works fails to perform to the design specifications, the first step in determining liability is to review all the potential causes for the failure. The causes may include a variety of circumstances such as design deficiencies, failure of a construction contractor to perform in a manner provided for in the plans and specifications, functional deficiencies in major equipment items, systems and unit processes that are furnished by subcontractors and suppliers, failure of the owner to properly maintain and operate the plant, and unanticipated changes in influent characteristics. The U.S. General Accounting Office (GAO) studied 24 publicly owned treatment works (POTW's) and determined that EPA regulations failed to assure that designs were complete and accurate or would be performed as designed. The GAO concluded that EPA should encourage grantees to hold the consulting engineers accountable for damages resulting from his work, and ensure that consulting engineers are held responsible for the poor performance of their resident engineers. Information is presented on POTW's that are in violation of discharge permits, and legislation, such as 1987 amendments to the Clean Water Act, that were designed to limit the number of violations. EPA grant annulments or terminations are one method employed to keep municipalities in line. Municipalities that feel poor plant performance is the result of faulty engineering or construction are entitled to take legal action against contractors. Background information on litigation and claims to either protect a municipality before construction, or when legal consultation is necessary is provided. Defenses and damages to the plaintiff, such as betterment, restitution, punitive and consequential damages, are possible legal remedies. (Author's abstract)
W90-04877

WORLD'S ONLY ON-LINE TALKING WASTEWATER TREATMENT PLANT.
Indianapolis Public Works Dept., IN.
M. W. Sweeney, J. E. Alleman, and T. J. Quinn.
Water Environment and Technology, Vol. 1, No. 2, p 306-311, October 1989. 1 fig.

Descriptors: *Wastewater facilities, *Indiana, *Wastewater treatment, Automation, Wastewater management, Computers.

The computerization of the wastewater treatment industry has been both beneficial and burdensome. Adjusting to the high technology has been expensive and the amount of data provided by the systems has been overwhelming at times. Computerized voice generation has become a commonplace technology within the public domain. Indianapolis, Indiana, recently introduced a similar capability to complement its new computer-generated trend inferring system, thereby activating what is believed to be the world's only on-line talking wastewater treatment plant. In Indianapolis, an IBM AT-PC is linked to the existing mainframe computer and data is monitored through the PC, which has an inserted digital recording/playback board. This expansion allows the computer to receive phone calls and relate near real-time plant status reports and critical alarm conditions. This vocal interface can automatically initiate telephone or voice pager calls to advise operators of abnormal or emergency conditions. The vocal PC has stretched the reach of Indianapolis' mainframes well beyond the control room and into the ears of any plant operator or manager possessing a telephone. (Male-PTT)

W90-04878

DESIGNING VENICE'S WASTEWATER SYSTEM.
Venice Public Drainage Dept., Padua (Italy).
P. Guidone.
Water Environment and Technology, Vol. 1, No. 2, p 316-319, October 1989.

Descriptors: *Wastewater treatment, *Water pollution control, *Venice, Wastewater facilities, Canals, Conduits, Design criteria.

For centuries, wastewater has been directly discharged to the many canals that separate over 100 islets in Venice, Italy. The first attempt to prevent direct discharge of wastewater to the canals was made in 1857. In 1899, an experimental project to build wastewater collection pipes and install cesspools for household discharges was conducted in a small section of the city. These pipes extended into the canals and allowed regular outflow of wastewater while daily tides drained conduits, which were later expanded throughout the city. More recent projects such as the construction of long-distance wastewater systems and biological purification plants have not yet been completed. Venice's canals are presently highly polluted as a result of a totally inadequate wastewater system. Collection system problems, such as the extreme discontinuity of the city's structure, will be worked out through design and system planning. It is proposed that collecting network pipes will be separated and use gravity flow. Plans for the treatment facility, which will be located on Lido Island consist of a gravity collection system for each islet, connected to a storage tank with pumps. Wastewater will then be pumped to the pressure conduit in the nearest canal where it will be pumped to the treatment plant. (Male-PTT)
W90-04880

USE OF REDOX POTENTIAL TO CONTROL FERRIC SULPHATE DOSING DURING PHOSPHATE REMOVAL.
Naiad Aquatic Environmental Services, Norwich (England).
P. H. Kerrison, B. McEwen, G. L. Phillips, and B. V. Crook.
Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 3, No. 4, p 397-403, August 1989. 4 fig, 2 tab, 4 ref.

Descriptors: *Water pollution control, *Wastewater treatment, *Phosphorus removal, *Oxidation-reduction potential, Enrichment, Ecological effects, Sedimentation, Nonpoint pollution sources, Cost analysis, Maintenance costs, Control systems, Performance evaluation.

In recent years, the Norfolk Broads have been enriched with sewage effluent and runoff from heavily fertilized land. Nitrogen and phosphorous compounds from these sources can cause ecological problems by stimulating increase in algal biomass in the water, so part of Anglian Water's program of research in Broadland has been to remove phosphate from major sewage effluents discharged to the Rivers Ant and Bure. This is achieved by dosing ferric sulfate to secondary effluent and settling the resultant insoluble complex. At three sites on the River Bure, the performance of timeclock-based and redox-based dose control systems was evaluated. Redox control, by restricting dosing when phosphate load was low, increased the efficiency of phosphate removal and produced up to 19 percent savings in chemical costs. Modifications are described which made the system self-regulating and ensured that savings were not eroded by maintenance costs. The system now operates efficiently and routinely at major sites on the Rivers Ant and Bure. (Author's abstract)
W90-04911

DOWNTOWN COMMUNITY APPROVES A NEW WASTEWATER PLANT.
B. Alberts, and G. Culp.
Water Engineering and Management WENMD2, Vol. 136, No. 9, p 29-35, September 1989. 2 fig.

Descriptors: *Wastewater facilities, *Secondary wastewater treatment, *Urban areas, *Public participation, Odor control, Noise, Construction costs, Washington.

A wastewater treatment plant was approved for construction in the heart of Edmonds, Washington. A three-acre downtown site will host the treatment facility. Since most of the new secondary facilities must be built in the space currently occupied by the older primary plant, primary treatment must be maintained while the new plant is built. Although the public approved building the new plant on the existing plant site, there were concerns about controlling the odors and noise from the plant. Odor control is provided by exhausting air from the raw-sewage pumping station, the primary clarifiers, and the solids-processing building through a 20,000 cu ft/min packed-bed countercurrent scrubber. To reduce the impacts from construction activities, construction is restricted to daytime hours throughout the construction period. Construction equipment is restricted to the staging areas or designated access and is located as far as possible from residences. The construction costs for the project were estimated at \$32.6 million. (Male-PTT)
W90-04921

SAND/ANTHRACITE FILTRATION COMPLEMENTS TRICKLING-FILTER SYSTEMS.
T. G. Weaver.
Water Engineering and Management WENMD2, Vol. 136, No. 9, p 47-50, September 1989. 1 tab.

Descriptors: *Wastewater treatment, *Filtration, *Sand filters, *Carbon filters, *Trickling filters, Wastewater facilities, Nitrification, Water quality standards, Financing, Texas.

Needing to update its facilities, the Cibolo Creek Municipal Authority near San Antonio, Texas, applied for Federal grant money, but was turned down. In order to revamp the treatment plant, revenue bonds and capital recovery fees were used for project funding. The facility, which serves 32,000-70,000, was designed using low energy and no chemicals. Filter media contains sand and anthracite. The trickling-filter media was installed in alternate vertical and crossflow layers, and have proved to be highly effective nitrification towers. Water quality, operational economy, efficiency and maintenance reliability are consistently high, and the plant always surpasses tertiary-effluent standards. (Male-PTT)
W90-04922

INFLOW REDUCTION ELIMINATED NEED FOR NEW INTERCEPTOR.
Dallas City Water Utilities Dept., TX. Operations Analysis Div.
R. Goss, and R. Thornhill.
Water Engineering and Management WENMD2, Vol. 136, No. 9, p 52-55, September 1989. 2 tab.

Descriptors: *Sewer systems, *Infiltration, *Storm water management, *Urban watersheds, Interceptor sewers, Simulation analysis, Construction costs, Texas.

The city of Dallas, Texas, has rehabilitated inflow/infiltration sources, rather than construct a new interceptor. The Turtle Creek drainage area passes 803,000 feet of sewer lines through the downtown and serves 54,000 people. It is located in the central part of Dallas and includes a small portion of the city of Dallas, almost all of the town of Highland Park, and all of the city of University Park. After intensive surveys and monitoring of the area, several plans for construction and rehabilitation were proposed: (A) Construction of new interceptor and main sewers to transport existing wet-weather flow with no removal of infiltration and inflow sources; (B) rehabilitation of infiltration and inflow control in the Dallas basins with construction of new main sewers to transport the remaining wet-weather flow, and a new interceptor sewer in the Park Cities to transport existing wet-weather flow; or (C) rehabilitation of infiltration and inflow control in both the Dallas basins and the Park

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Cities, with construction of new main sewers in the Dallas basins but no interceptor sewer for the Park Cities. Alternative (C) is the least costly by approximately \$3.7 million. The final recommendation is based on the results of a computer analysis that simulated a 2-year storm event after the rehabilitation of infiltration/inflow control and 50% reduction of inflow in the Park Cities and a resultant hydraulic gradient analysis of identified overloaded sewers. It was recommended that 1761 linear feet of relief sewers be constructed to transport the projected peak flow after rehabilitation is implemented. (Male-PTT)
W90-04923

NITRIFICATION FOR THE '90S.

Brown and Caldwell, Denver, CO.

C. Paulson.

Water Engineering and Management WENMD2, Vol. 136, No. 9, p 57-72, September, 1989. 1 tab.

Descriptors: *Wastewater treatment, *Nitrogen removal, *Biological wastewater treatment, *Trickling filters, Ammonia, Nitrification, Biofilms, Operating costs.

A pilot study completed in 1988 at the Central Valley Water Reclamation Facility in Salt Lake County, Utah, has demonstrated that nitrifying trickling filters (NTFs) may be the wave of the future as far as ammonia removal is concerned. Ammonia removal ranks as a major new issue for many wastewater treatment managers, particularly at plants that discharge into warm-water streams with seasonal low flows. Consistent biofilm development was identified as their key to getting high nitrification rates by the pilot-study team. Operating costs with the biofilm are expected to be about half what activated sludge would cost. (Author's abstract)
W90-04924

EFFECT OF SLUDGE DIGESTION ON METAL SEGREGATION DURING OCEAN DUMPING.
Delaware Univ., Newark. Coll. of Marine Studies. For primary bibliographic entry see Field 5E.
W90-04967

OPTIMUM DESIGN OF SEWAGE SLUDGE CONSOLIDATION TANKS.

G. Hoyland, A. Dee, and M. Day.

Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 3, No. 5, p 505-516, October 1989. 6 fig, 3 tab, 8 ref.

Descriptors: *Wastewater facilities, *Sanitary engineering, *Wastewater treatment, *Design criteria, *Sludge thickening, Mathematical models, Sludge drying, Dewatering, Performance evaluation, Wastewater treatment, Compaction, Sludge solids, Optimization.

A procedure based on a mathematical model was developed by the Water Research Center for designing sewage sludge consolidation tanks operating in a continuous or batch mode. The procedure ensures that the size and height of the tank accords with the consolidation properties of the particular sludge. According to the new procedure, for any particular sludge, there is an optimum tank design, expressed in terms of a specific plan area and blanket height, that maximizes performance. Continuous consolidation tanks designed optimally have the potential to perform better than batch tanks designed optimally. Optimum specific plan areas for batch and continuous tanks are similar in value but continuous tanks are taller. Optimum designs are sensitive to the season of the year and sludge temperature. To obtain predicted performance in practice, the various support systems that comprise the consolidation plant must be properly designed and operated. This is particularly relevant for continuous plants, since their performance is very sensitive to the operational conditions. The new design procedure would be applicable to any sludge composed of compactible particles. (Geiger-PTT)
W90-05018

SIMPLIFIED EQUATIONS FOR EFFECTIVE-NESS FACTORS IN ANAEROBIC BIOFILMS.

Gunma Univ., Maebashi (Japan). Dept. of Civil Engineering.

M. Kuroda, Y. Sakakibara, and C. R. Escalera.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1123-1138, December 1989. 11 fig, 2 tab, 10 ref, append.

Descriptors: *Biofilms, *Wastewater treatment, *Biological filters, *Anaerobic conditions, *Biological wastewater treatment, Decomposition, Mathematical models, Theoretical analysis, Diffusion coefficient, Mathematical equations, Performance evaluation.

The diffusion effects occurring in a biofilm in which a consecutive bioreaction takes place are studied theoretically, and effectiveness factors (E_f), which evaluate the effect of the diffusion rates on substrate decomposition rates, are represented by a simple algebraic relation expressed in terms of normalized substrate bulk concentrations (B) and normalized characteristic biofilm parameters. On the other hand, the overall decomposition rates of the substrates can be expressed by a Monod-type equation for the substrate bulk concentration. The apparent half velocity constants in the Monod-type rate equation are affected by the diffusion and biochemical reaction rates of the substrates. The ratio of the apparent half velocity constants to the corresponding specific half velocity constants (λ_{Bd}) is related to E_f . The relationship is expressed in the following equation: $E_f = (1 + B)/(\lambda_{Bd} + B)$. The applicability of these theoretical relations is experimentally demonstrated in volatile fatty acids decomposition. This equation may be rationally used for the design and/or performance of biofilm reactors. (Author's abstract)
W90-05022

SLUDGE DIGESTION BY ANAEROBIC FLUIDIZED BEDS: I. LAB PERFORMANCE DATA.

Missouri Univ.-Rolla. Dept. of Civil Engineering.

J. C. Huang, and Y. J. Huang.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1139-1155, December 1989. 5 fig, 4 tab, 17 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Sludge digestion, *Sludge disposal, *Fluidized bed process, Sodium hydroxide, Retention time, Temperature effects, Chemical oxygen demand, Performance evaluation, Organic acids.

The effect of initial sludge solubilization on the laboratory performance of an anaerobic fluidized bed digesting secondary biological sludge at 15, 25 or 35 °C was evaluated at hydraulic-retention times of 1, 2.5, 5, and 10 days. At 35 °C, an adequate degree of sludge digestion was observed with a hydraulic retention time of only 1-2 days if the influent biological sludge was presolubilized by treatment with 17.5 mg/liter of sodium hydroxide. If no presolubilization was used, the necessary hydraulic retention time was increased to 10 days. When the temperature was decreased to 25 °C and sludge was presolubilized, the required hydraulic retention time was 2.5-3 days. However, as the temperature was further decreased to 15 °C, the system was unable to achieve adequate digestion in as long as 10 days, even with presolubilization. In addition at 35 °C the fluidized-bed system was able to accept abrupt increased loading without a corresponding buildup of excessive organic acids. (See also W90-05024) (Geiger-PTT)
W90-05023

SLUDGE DIGESTION BY ANAEROBIC FLUIDIZED BEDS: II. KINETIC MODEL.

Southern Illinois Univ. at Carbondale. Dept. of Civil Engineering and Mechanics.

B. T. Ray, J. C. Huang, and B. A. Dempsey.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1156-1170, December 1989. 5 fig, 1 tab, 11 ref, append.

Descriptors: *Wastewater treatment, *Fluidized bed process, *Sludge digestion, *Anaerobic digestion, *Model studies, Kinetics, Suspended solids, Biomass, Particulate matter, Chemical oxygen

demand, Sludge disposal, Activated sludge, Digester gas.

A model was developed to describe the gas production and soluble-COD variations from the digestion of waste-activated sludge in the anaerobic fluidized-bed reactor. The model indicates that a substantial rate increase can be attained by prehydrolysis of the biological sludge, external to the reactor and that the rate-limiting step is in the sludge hydrolysis. The model is developed from an assumption of first-order kinetics in a set of series and parallel, irreversible reactions. The formation of soluble substrate is first order with respect to the particulate biomass present, and the production of methane is first order with respect to the soluble substrate present. The amount of particulate biomass can be approximated by the sludge-suspended solids and the amount of soluble substrate can be approximated by the soluble COD present in the reactor. The model correlates well with the laboratory data observed in the study. (See also W90-05023) (Author's abstract)
W90-05024

OPTIMUM DESIGN OF LARGE SEWER NETWORKS.

Kuwait Inst. for Scientific Research, Safat. Techno-Economics Div.

A. A. Elimam, C. Charalambous, and F. H. Ghobrial.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1171-1190, December 1989. 4 fig, 4 tab, 11 ref, append.

Descriptors: *Sewer systems, *Sewer hydraulics, *Mathematical models, *Design criteria, Roughness coefficient, Hydraulic friction, Hydraulic roughness, Regression analysis, Optimization, Linear programming.

A linear programming, diameter discretization, heuristic approach is presented for the optimum design of large gravity sewer networks. The mathematical model contains a nonlinear convex function relating pipeline diameter and slope, which is approximated by piecewise linear segments. This approach uses a modified Hazen-Williams hydraulic model at part-full flow conditions, along with a newly developed universal expression to determine the coefficient of roughness. Moreover, the hydraulic formulation contains a regression equation to determine Darcy's friction factor based on the depth of flow in the pipe. The developed model has been extensively and successfully used to design several large sewer networks. (Author's abstract)
W90-05025

MODELING FOR CLASS-I SEDIMENTATION.

Roorkee Univ. (India). Dept. of Civil Engineering.

D. S. Bhargava, and K. Rajagopal.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1191-1198, December 1989. 5 fig, 2 tab, 4 ref.

Descriptors: *Wastewater treatment, *Water treatment, *Mathematical models, *Model studies, *Settling tanks, *Sedimentation, *Particle size, Settling velocity, Suspended solids, Particulate matter, Mathematical studies, Design criteria.

Sedimentation is the most-widely-used unit operation for the removal of organic and inorganic settleable solids from water or wastewater. The design of class-I (discrete particles) settling tanks would be more rational and economical if designed for overall particle removal rather than for an overflow rate based on the smallest particle to be removed. The overall percentage removals of discrete particles corresponding to different overflow rates were evaluated for several sets of samples having different sieve-analysis parameters (different combinations of the effective size and the non-uniformity coefficients). A predictive model has been developed for evaluating the overall percentage removal from sieve-analysis parameters, such as the effective size and the nonuniformity coefficient of the discrete particles present in the influent. Such a model can be used for a rational fixing

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of the design overflow rate to provide the desired overall percentage removal of the particles of a given size distribution. The experimentally observed data of several other researchers are found to be in total agreement with the values predicted from the writer's model. This justifies the robustness of the presented model. (Author's abstract) W90-05026

BIOACTIVE ADSORBER MODEL FOR INDUSTRIAL WASTEWATER TREATMENT.

University of Southern California, Los Angeles. Dept. of Civil Engineering. S. H. Kim, and M. Pirbazari. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1235-1256, December 1989. 10 fig, 5 tab, 31 ref.

Descriptors: *Industrial wastewater, *Fluidized bed process, *Biological wastewater treatment, *Wastewater treatment, *Mathematical models, *Adsorption, *Biodegradation, *Biological filters, Diffusion coefficient, Finite difference methods, Kinetics, Landfills, Activated carbon, Leachates, Animal wastes.

A predictive mathematical model that describes the adsorption and biodegradation phenomena in recycle fluidized-bed (RFB) adsorbers was developed. The model incorporated liquid film transfer, biodegradation and diffusion in the biofilm, adsorption onto activated carbon, and biofilm growth. The model equations were solved by a combinatorial technique involving the methods of orthogonal collocation and finite differences. Computer simulations of the model were used for adsorber performance predictions from parameters obtained from adsorption equilibrium and kinetic studies, biokinetic experiments, and correlation techniques. Sensitivity tests were also performed to determine the effect of physical and biological parameters on model profiles. Recycle fluidized adsorber experiments were conducted to test the predictive capability of the model. Two ideally biodegradable compounds, glucose and sucrose, as well as two actual wastewaters, a dairy waste and a landfill leachate, were used to compare the predicted model profiles with experimental data for non-bioactive and bioactive RFB adsorbers. The performance predictions obtained from modeling were in satisfactory agreement with the experimental data. (Author's abstract) W90-05029

EFFECT OF WASTEWATER APPLICATION DEVICE ON AMMONIA VOLATILIZATION.

Dames and Moore, Atlanta, GA.

J. Zirschky, and D. Crawford.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1258-1263, December 1989. 2 tab, 6 ref.

Descriptors: *Wastewater treatment, *Ammonia removal, *Land disposal, *Ammonia, *Sprinklers, *Volatility, Wastewater analysis, Hydrogen ion concentration, Temperature effects, Fate of pollutants, Overland flow, Nitrogen removal, Texas, Seasonal variation.

The differences in ammonia volatilization efficiency between wastewater application devices was studied on five overland-flow terraces on a 12-acre pilot test plot in Garland, Texas. Low-pressure fan nozzles, gated pipe, and two nozzle-size sprinklers (0.7 cm and 0.8 cm) were used in the pilot system. Influent samples collected directly from the gated pipe were used as the reference point for determining the amount of ammonia volatilization that occurred with the other devices. Wastewater samples were collected from each of the application devices and were analyzed for ammonia nitrogen. Data compiled on fifteen samples collected over approximately one year was analyzed by the sign test. Median ammonia removals by volatilization ranged from 2.8% for fan nozzles to 7.4% and 11.6%, respectively, for the 0.8-cm and 0.7-cm sprinklers. The amount of volatilization achieved by sprinkler nozzles was significantly greater than by the fan nozzles. No relationship was apparent between pH and the amount of ammonia nitrogen volatilized. There was also no apparent relation-

ship between air temperature and the amount of ammonia volatilized. The season of the year did appear to be a factor, with less ammonia volatilized during the colder months from November to February. Sufficient data were not obtained to make a conclusive determination of the effect of air temperature and pH on ammonia volatilization. Water temperature or physical factors (wind speed) may be controlling factors, but were not measured in this study. (Geiger-PTT) W90-05030

ANAEROBIC WASTEWATER TREATMENT.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering. M. T. Suidan, J. T. Pfeffer, G. F. Nakhla, J. Fraser, and B. E. Klepp. Available from the National Technical Information Service, Springfield, VA 22161, as DE88-001062. Price codes: A10 in paper copy, A01 in microfiche. Report No. DOE/MC/21281-2562, November 1987. 207p, 77 fig, 16 tab, 29 ref. DOE Contract DE-AC21-84MC21281.

Descriptors: *Chemical wastewater, *Biological wastewater treatment, *Anaerobic digestion, *Wastewater treatment, Granular activated carbon, Coal gasification, Chemical oxygen demand, Methane, Load distribution, Performance evaluation.

Coal gasification has been regarded as one of the more promising technologies for the production of the gaseous fuels needed to supplement dwindling reserves of petroleum and natural gas. If the commercialization of coal gasification is not to be inhibited by environmental problems, however, it becomes necessary to develop effective and reliable processes for the treatment of the resulting condensate wastewater. This research project was undertaken to evaluate the effects of wastewater dilution, granular activated carbon (GAC) replacement rate, GAC particle size, operating temperature, and reactor configuration on the treatment of coal gasification wastewater with the expanded bed GAC anaerobic bioreactor. Full-strength coal gasification wastewater was found to be effectively treated at chemical oxygen demand (COD) loading rates as high as 19.4 g/kg GAC-day. At this loading rate, an excess of 50% of the applied COD was converted to methane, and a carbon utilization rate of 10 g GAC/L of wastewater treated as employed. At these operating conditions, COD removal efficiencies across the treatment system exceeded 95%. Dilutions of the wastewater of 30% and 60% permitted efficient and stable waste treatment at even higher COD loading rates. Good COD removal and efficient COD conversion to methane were attainable at loading rates exceeding 60 g COD/kg GAC-day. Another coal gasification wastewater was found to be treatable at full-strength in the expanded bed GAC anaerobic reactor at COD loading rates as high as 48 g COD/kg GAC-day. COD removal efficiencies at this loading rate exceeded 90%. (Lantz-PTT) W90-05132

DETERMINATION OF CALCIUM, MAGNESIUM, AND SODIUM IN WASTEWATER BY INDUCTIVELY COUPLED PLASMA SPECTROSCOPY.

Westinghouse Materials Co. of Ohio, Cincinnati. Feed Materials Production Center.

B. S. Barnes, and A. F. Volesky.

Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016502. Price codes: A03 in paper copy, A01 in microfiche. Report No. FMPC-2120, October 1988. 12p, 6 tab, 1 ref. DOE Contract DE-AC05-860421600.

Descriptors: *Wastewater analysis, *Wastewater treatment, *Calcium, *Magnesium, *Sodium, *Plasma spectroscopy, Industrial wastewater, Spectrometry, Chemical analysis, Statistical analysis, Water quality control.

Inductively coupled plasma-atomic emission spectroscopy (ICP-AES) has been used for the determination of calcium, magnesium, and sodium in industrial wastewater samples. The method developed employs the Qualitative mode of a Leeman

Labs Plasma-Spec III Inductively Coupled Plasma (ICP) Spectrometer. Analytical results using the Qualitative mode were compared to those obtained using ICP Sequential analysis, flame atomic absorption spectrophotometry (AAS), and flame emissions. The average difference between the two modes for calcium was 0.85 plus or minus 1.45 mg/L. The average relative difference is 1.6% plus or minus 3.1% of the average concentration. In the magnesium analyses, the average difference was 1.88 plus or minus 11.1 mg/L. This represents an average relative difference of < 0.35% plus or minus 2.6% of the average concentration. Twenty-two samples were analyzed for sodium by sequential and qualitative analysis. The average difference between the two modes was 22.7 plus or minus 21.1 mg/L. This represents an average difference of 2.0% plus or minus 2.0% of the average concentration. As part of the original biodegradation (BDN) demonstration test program, a control/recycle program was initiated. At least one control sample was analyzed with each set of analyses. The controls were synthetic BDN waters, containing anions and cations in concentration ranges approximating those of the samples at three different levels. Forty-seven calcium and magnesium control samples were analyzed; twenty-seven sodium controls were analyzed. The differences between the expected and determined values were evaluated statistically. For calcium, the per cent recovery for the controls ranged from 93.6% to 101.5%. For magnesium, per cent recoveries are from 97.6% to 101.6%. With sodium, recoveries range from 93.1% to 97.2%. (Lantz-PTT) W90-05135

MICROCOMPUTER MODEL FOR SIMULATING PRESSURIZED FLOW IN A STORM SEWER SYSTEM.

Virginia Transportation Research Council, Charlottesville.

For primary bibliographic entry see Field 8B.

W90-05136

ARTIFICIAL INTELLIGENCE FOR U.S. ARMY WASTEWATER TREATMENT PLANT OPERATION AND MAINTENANCE.

Construction Engineering Research Lab. (Army), Champaign, IL.

B. J. Kim, J. T. Bandy, K. K. Gidwani, and S. P. Shelton.

Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 434. Price codes: A03 in paper copy, A01 in microfiche. USA-CERL Technical Report N-88/26, September 1988. 43p, 6 fig, 1 tab, 20 ref.

Descriptors: *Wastewater facilities, *Computer programs, *Maintenance, *Automation, *Artificial intelligence, Wastewater treatment, Computers, Expert systems, Economic aspects.

As the Army faces increasing reductions in budget and personnel for supporting functions such as operation and maintenance (O and M) of wastewater treatment plants (WWTPs), it is clear that reliance on automation will continue to grow. While computer systems will not replace operators, they will provide valuable assistance in optimizing the operator's time and effort. An emerging technology with potential application to WWTP O and M is artificial intelligence (AI)/expert systems. These systems use knowledge bases developed by experts in a given field combined with a 'reasoning' chain of logic to provide diagnostic and control functions. This study has investigated opportunities for exploiting AI and expert systems for increasing the performance and reducing the cost of Army WWTP O and M. In addition, a general orientation to the technology has been provided to assist Army personnel in making decisions about its applicability to their installations. Findings suggest that AI/expert systems technology is not yet at an economically practical level for use in O and M of the Army WWTPs. However, as the technology becomes refined and produced at a lower cost, it should be reconsidered; this study has shown through a proof-of-concept exercise that AI/expert systems have potential value to the O and M process. (Author's abstract)

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Group 5D—Waste Treatment Processes

W90-05144

DYNAMIC MODELING AND EXPERT SYSTEMS IN WASTEWATER ENGINEERING.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 395 p. Edited by G. G. Patry and D. Chapman.

Descriptors: *Expert systems, *Artificial intelligence, *Dynamic models, *Wastewater treatment, *Model studies, *Sanitary engineering, Waste management, Wastewater pollution, Wastewater management.

The book is the result of a workshop held at McMaster University (May 19-20, 1988), at which a select group of authors and participants were invited to share their experiences. Brought together is current work on dynamic modeling and expert systems as applied to the design, operation, and control of wastewater treatment systems. The book is divided into three major sections: (1) dynamic modeling of wastewater treatment systems including receiving water body interactions; (2) the application of expert systems to wastewater engineering; and (3) system identification and control. (See W90-05150 thru W90-05160) (Lantz-PTT) W90-05149

DYNAMIC MODELING OF SUSPENDED GROWTH BIOLOGICAL WASTEWATER TREATMENT PROCESSES.

Clemson Univ., SC. Dept. of Environmental Systems Engineering.
C. P. L. Grady.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 1-38, 2 fig, 3 tab, 54 ref.

Descriptors: *Dynamic models, *Wastewater treatment, *Model studies, *Biological wastewater treatment, Biological treatment, Sludge treatment, Oxidation, Nitrification, Denitrification, Aerobic treatment, Bacteria, Ammonification, Phosphorus removal.

The model for single-sludge wastewater treatment systems performing carbon oxidation, nitrification and denitrification, developed by the IAWPRC task group, is reviewed. The rationale for all components and the rate expressions for the processes acting on them are presented. Among the processes included are aerobic growth of heterotrophic bacteria, anoxic growth of heterotrophic bacteria, aerobic growth of autotrophic bacteria, decay of both heterotrophic and autotrophic bacteria, ammonification of soluble organic nitrogen, and hydrolysis of both particulate organic matter and particulate organic nitrogen. After considering the approach taken by the IAWPRC task group, alternative approaches suggested by current research are proposed. Finally, future directions, particularly with regard to the modeling of biological phosphorus removal and the fate of individual organic compounds, are discussed. (See also W90-05149) (Lantz-PTT) W90-05150

MATHEMATICAL MODELING OF FIXED-FILM GROWTH.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
B. E. Rittmann.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 39-57, 1 fig, 1 tab, 19 ref.

Descriptors: *Mathematical models, *Fixed film processes, *Model studies, *Biological wastewater treatment, *Wastewater treatment, Biofilm reaction, Process control, Expert systems.

Fixed film biological processes, especially innovative fixed bed and fluidized bed processes, offer the advantages of excellent substrate removal efficiencies and small reactor volumes. However, the small volumes can make these biofilm processes sensitive to loading fluctuations, which can deteriorate effluent quality during the loading shocks and over the long term. Real-time process control offers an

opportunity to mitigate adverse effects of load fluctuations. To effect real-time control, an accurate model of the transient response of the biofilm process is essential. Construction of models for biofilm processes that describe transient responses to substrate-load fluctuations is possible with the biofilm-kinetics tools already available. Limited experimental evaluation of transient models has shown that they can describe the transient phenomena of biofilm initiation and growth to a steady state, as well as substrate utilization. Innovative biofilm processes offer the benefits of small reactor sizes, but they also are susceptible to fluctuations in loading of substrate and toxic materials. Process models that describe the process response to input of inhibitory materials or when physiological or ecological changes occur are not available. Fundamental new information on the mechanisms acting and on how they should be quantitatively represented is required first. Full implementation of real-time control also requires significant improvements in on-line monitoring of key process parameters and the collaborative development of expert systems that can use the input information and interact with the transient model. These two future needs will require a sizable effort before they are ready for reliable real-time control. (See also W90-05149) (Lantz-PTT) W90-05151

CONTINUOUS SETTLER OPERATION: A DYNAMIC MODEL.

Municipality of Metropolitan Seattle, WA.
Z. Vitasovic.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 59-81, 11 fig, 19 ref.

Descriptors: *Wastewater treatment, *Sedimentation, *Model studies, *Dynamic models, *Activated sludge process, Thickening, Suspended solids, Mathematical models.

A model was developed to simulate thickening behavior from secondary activated sludge solids-liquid separators. Simulations were conducted for a number of flow conditions. The solids concentration profile within the settler predicted by the model was in agreement with data found in the literature. Failure of the settler due to a rising sludge blanket or inadequate thickening were successfully predicted by the model. The thickening model extends previous models to include zones above the point where mixed liquor enters the solids-liquid separator. The thickening model also includes provisions for predicting failure of the thickening function, with unthickened sludge being withdrawn from the underflow line. Work is underway to add significantly the level of sophistication of the hydraulic portion of the model. Available empirical models may be used to predict gross changes in clarification behavior, but are inadequate to describe settler performance accurately for a low range of effluent suspended solids (< 10 mg/L). Based on data obtained from a full-scale sewage treatment plant producing a high quality effluent, random processes appear to play a significant role in determining the solids concentration within the clarifier overflow. Including a stochastic component has a potential of improving the accuracy of the clarification models to describe the low end of the effluent turbidity signal. (See also W90-05149) (Lantz-PTT) W90-05152

DYNAMICS, STABILITY AND CONTROL OF THE ANAEROBIC DIGESTION PROCESS.

Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
J. F. Andrews.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 83-127, 1 tab, 32 ref. NSF Grant CES-8704105.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Model studies, *Dynamic models, *Process control, Temperature, Toxicity, Computer models, Sludge digestion, Hydrogen ion concentration, Alkalinity.

Research on dynamic modeling of an anaerobic digester and use of the model to explore techniques for predicting and preventing process failure is summarized. The model can predict process failure by four events: hydraulic overloading, organic overloading, toxicity, and changes in temperature. It can also predict the dynamic responses of the five variables most used to indicate process state; volatile acids, pH, alkalinity, gas flow rate, and gas composition. Computer simulations are used to explore techniques for improving process stability and control strategies for prevention of failure. These indicate that stability can be enhanced by increasing detention time, alkalinity, and influent substrate concentrations, and by the recycle of concentrated digested sludge. Several control systems are examined and found to be effective for prevention of failure with the effectiveness of the strategy being dependent on the type of failure to be prevented. These systems are: (1) the recycle of digester gas from which carbon dioxide has been removed by a gas scrubber; (2) base addition; and (3) recycled and digested sludge. Research in progress includes the incorporation of additional reactions into the model with special emphasis on the roles of propionic acid and hydrogen in process failure. A computer-based operational assistant, based on model predictions and expert systems technology, is being developed to assist in digester operation. (See also W90-05149) (Lantz-PTT) W90-05153

WASTEWATER TREATMENT AND RECEIVING WATER BODY INTERACTIONS.
Environmental Protection Agency, Cincinnati, OH.

L. A. Rossman.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 129-166, 19 fig, 3 tab, 23 ref.

Descriptors: *Model studies, *Dynamic models, *Wastewater pollution, *Wastewater treatment, *Wastewater disposal, *Water pollution control, *Waste load, Pollution load, Ammonia, Toxicity, Water quality.

The dynamic nature of the interactions between wastewater discharges and receiving water quality can complicate the analysis of pollution abatement programs. A numerical example of ammonia toxicity is used to illustrate this point. It shows the role that correlated variables, chemical transformations, and water quality criteria play in determining water quality responses and their environmental significance. Several methods of waste load allocation—dynamic response approach, dynamic assimilative capacity approach, and steady-state response approach—that take these dynamic interactions into account are reviewed. Also reviewed are pollution control strategies based on variable effluent limits. These can lower treatment costs by allowing discharge levels to change by time of year or with conditions in the receiving water. A waste load allocation method for seasonal discharge limits is introduced that maintains an equal risk of water quality criteria violation with nonseasonal limits. Illustrations of these various approaches to waste load allocation are provided for ammonia toxicity example studies. (See also W90-05149) (Lantz-PTT) W90-05154

APPLICATIONS OF EXPERT SYSTEMS IN THE PROCESS INDUSTRY.

Stone and Webster Engineering Corp., Boston, MA.

G. A. Finn.
IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 167-192, 10 fig, 25 ref.

Descriptors: *Process control, *Wastewater treatment, *Expert systems, Computer programs, Maintenance, Technology.

Expert systems are computer systems that represent knowledge and experience of recognized experts in a particular field. Expert systems provide

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an incremental, evolutionary mechanism for distributing expert knowledge and helping to improve the performance of engineers, operators, and technicians. Applications development and implementation may be motivated by the preponderance of near-retirement age expert personnel in engineering, operations, and maintenance. Increased emphasis on improving product quality and yield, and a heightened focus on improving efficiency, both in the process and in utility support, also provide clear opportunities and needs for expert system applications. The ability to develop and apply expert systems is based largely on the availability of software tools that allow non-computer specialists to develop applications easily. These tools, commonly called shells, provide capabilities for including knowledge in the form of English-like rules. The shells incorporate methods for reasoning, and allow the developers to focus on the application-specific knowledge. This capability eliminates the requirements that the development process be a programming exercise. Most expert systems applications in the process industry have been directed toward diagnosis, in the form of equipment trouble-shooting, process diagnosis, inspection, and equipment failure analysis. Other applications have been suggested or developed for process/manufacturing, scheduling, design, and process planning. The vast majority of applications have been off-line, consultative, and advisory in nature, but successful implementations in real-time, or on-line process monitoring and diagnosis are now being tested in the field. Through the maturation of the basic expert system technology and the development of new techniques (such as neural networks) expert systems are becoming an integral part of the engineering, planning, operations, and maintenance functions within the process industry. (See also W90-05149) (Lantz-PTT) W90-05155

KNOWLEDGE-BASED SYSTEM FOR THE DIAGNOSIS OF AN ACTIVATED SLUDGE PLANT.

McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics. R. A. B. Gall, and G. G. Patry. IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 193-240, 30 fig, 1 tab, 29 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Expert systems, Maintenance, Process control, Sedimentation, Aeration, Clarification, Sludge thickening.

A knowledge-based system was developed to assist in the operation of wastewater treatment plants. The knowledge base, referred to as DASP (Diagnosis of the Activated Sludge Process) consists of a rule-based expert system for the diagnosis of the activated sludge process and subsequent identification of remedial control actions. The knowledge base was developed from: (1) an exhaustive literature review on wastewater treatment plant operation; and (2) site visits and interviews with experienced plant operators. The knowledge base was encoded using Personal Consultant Plus (Texas Instruments) and tested under actual plant operating conditions. The knowledge base consists of 169 rules and 97 parameters that are used to pursue 10 goals. The primary benefit of this structuring is that it allows groups of rules to be pruned, or trimmed, based on simple questions asked at the beginning of the consultation. This trimming quickly reduces the search space for the inference engine and prevents the consultation from becoming unnecessarily verbose. The goal parameters of the expert system are: Test, Location, Measurement, State, Trend, External, Industry, Equipment, Control, and Check. The rules developed for the diagnosis of an activated sludge system are described, and include: primary sedimentation rules, aeration basin rules, final clarifier/thickener rules, measurement rules, microscope observation rules, and control rules. It is difficult at this stage to assess the true potential benefits of this technology to wastewater treatment plant operation and control. However, it should be emphasized that the operational benefits of a knowledge-based system for activated sludge diagnosis depends largely on

the continuing contributions from plant operators. The knowledge base, no matter how sophisticated, should not be viewed as a static piece of software but should be updated on a regular basis to reflect the cumulative experience of the operators as well as changes and/or adjustments made to the different unit processes. (See also W90-05149) (Lantz-PTT) W90-05156

SYSTEM IDENTIFICATION AND CONTROL.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. M. B. Beck. IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 261-323, 177 fig, 71 ref.

Descriptors: *Process control, *Wastewater treatment, *Systems analysis, *Model studies, *Expert systems, Computers, Statistical models.

The limitations of the somewhat narrow interpretation of system identification as a problem of model calibration is discussed. Types of models include the following: (1) linguistic; (2) time-series; (3) lumped-parameter; and (4) distributed parameter. The procedure of system identification comprises the following component parts: (1) a priori analysis of model identifiability; (2) experimental design; (3) generating preliminary hypotheses; (4) selection and evaluation of model structure; and (5) parameter (and state) estimation. Case studies are included to give practical examples of system identification and comprise problems in modeling both the unit processes of wastewater treatment and the characteristics of the receiving water body. Expert systems are illustrated briefly for the case of bulking sludge. (See also W90-05149) (Lantz-PTT) W90-05158

PRACTICAL EXPERIENCES OF IDENTIFICATION AND MODELING FROM EXPERIMENTS.

Lund Univ. (Sweden). Dept. of Industrial Automation. G. Olsson. IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 325-344, 2 fig, 29 ref.

Descriptors: *Wastewater treatment, *Model studies, *Process control, *Dynamic models, Dynamics, Time series analysis, Clarification, Dissolved oxygen, Oxygen uptake, Mathematical studies.

The dynamics of a wastewater treatment plant cover a very wide spectrum which makes any model approach extremely complex. Time series identification is a useful tool for model verification. Generally the models obtained have a relatively low order (usually less than two or three) due to the disturbances involved. With limited potential for measurements and sensor accuracy, a gray box approach is often advantageous. A more structured model is adopted to real data. Recursive estimation is a viable method for updating time-varying parameters in wastewater treatment systems. The dynamics of secondary clarifiers can be tracked by recursive estimation in order to obtain an early warning system for changing floc properties. Another application is the on-line estimation of the oxygen uptake rate simultaneously with the oxygen transfer rate. A new method has been developed that allows both parameters to be time-varying. This gives the operator real-time information about the organism activity while dissolved oxygen (DO) is controlled automatically. Full-scale results are encouraging. Considering the non-linear and time-varying character of the DO dynamics the control of the DO concentration is not at all trivial. Good control can be obtained by self-tuning regulators for the DO concentrations. A survey of some results in the areas of time series analysis, structured identification, recursive identification and more advanced control methods, based on identification is presented. A model library is described and finally, some aspects of knowledge-based systems are discussed. (See also W90-05149) (Lantz-PTT) W90-05159

DYNAMIC MODELING AND EXPERT SYSTEMS IN WASTEWATER ENGINEERING: TRENDS, PROBLEMS, NEEDS.

Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre. D. T. Chapman, G. G. Patry, and R. D. Hill. IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 345-370, 5 fig, 30 ref.

Descriptors: *Sanitary engineering, *Dynamic models, *Expert systems, *Model studies, *Wastewater treatment, Process control, Dynamics, Computers, Technology, Artificial intelligence.

By taking process dynamics and data uncertainty into account, dynamic models and expert systems provide wastewater engineers with new techniques for planning, designing and operating sewerage systems and wastewater treatment plants. Advances have been made in these areas because of recent availability of new hardware and software tools. Dynamic models and expert systems will find application in planning wastewater engineering projects. These tools will assist engineers to develop seasonal or transient regulations for receiving waters, evaluate alternative basin-wide wastewater management strategies and screen treatment options to select the most promising ones. Simulations with dynamic models will provide information for the design of aeration systems for activated sludge systems, lift stations and systems for reducing combined sewer overflows. In the future, operations staff will also make use of expert systems and dynamic models. Simulations will enable control strategies to be tested prior to implementation and the validity of output from on-line sensors to be checked. To improve technology transfer, additional training is required for both the graduate and practicing environmental engineer. Government funding is required for a few well-chosen demonstration projects. (See also W90-05149) (Lantz-PTT) W90-05160

COMPTRAIN GUIDE: A MANUAL FOR IMPROVING THE PERFORMANCE OF SMALL WATER AND WASTEWATER SYSTEMS.

National Demonstration Water Project, Washington, DC.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134944. Price codes: A10 in paper copy, A01 in microfiche. National Demonstration Water Project, Washington, DC. November 1984. 213p, 11 append.

Descriptors: *Wastewater treatment, *Water treatment, *Comptrein, *Training, *Education, Project planning, Wastewater management, Performance evaluation, Standards.

National Demonstration Water Project (NDWP) is a nonprofit corporation established in 1972 as a vehicle for finding ways to improve the delivery of water supply and wastewater disposal services to small towns and rural areas at affordable prices. NDWP carries out its mission through: (1) demonstration projects designed to test innovative approaches to water and wastewater service delivery in the field; (2) publications and other technology transfer activities; and (3) policy analysis, recommendations, and training at federal, state, and local levels. One such training effort was the Comptrein Project, conducted from late 1982 to mid 1985. The goal of the Comptrein Project was to field test a method for bringing small water and wastewater treatment plants into compliance with federal-state performance standards. The method involves: (a) intensive, on-site, plant-specific training in equipment operation and process control; (b) community-specific management and financial training; and (c) efforts to bring about policy and program changes leading to improved plant performance. The training targets are plant operators, municipal officials, and state officials. This manual is intended for nonprofit organizations, state agencies and others interested in setting up a comptrein project. The manual is divided into four chapters, each chapter discussing one or more major steps in the comptrein methodology: project organization,

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target identification, problem diagnosis, corrective action, and project evaluation. Following the text are substantial attachments containing sample forms, guidelines and procedures that can be used in setting up and carrying out a compliance effort. (Lantz-PTT)
W90-05163

CAPITAL COSTS OF LIME TREATMENT AT THE AUGUSTA WASTEWATER TREATMENT PLANT.

Savannah River Lab., Aiken, SC. Technical Div. N. V. Halverson.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-001418. Price codes: A02 in paper copy, A01 in microfiche. Report No. DPST-88-747, August 17, 1988. 6p, 12 ref.

Descriptors: *Phosphorus removal, *Capital costs, *Wastewater facilities, *Wastewater treatment, *Economic aspects, Phosphorus, Algae, Activated sludge process, Chemical treatment, Biological treatment, Lime, Augusta, Sludge disposal.

The capital costs were estimated for the addition of lime treatment facilities to the Augusta sewage treatment plant as a means of reducing the phosphorus loading of Lake and consequently reducing the algae populations in the lake. The two types of lime treatment considered were primary lime treatment and tertiary lime treatment. The capital cost of a primary lime treatment addition would be lower than for a tertiary treatment addition. Depending on whether the existing primary settling tank can be utilized for lime treatment or a new clarifier must be built, a primary lime treatment addition would currently cost between \$500,000 and \$3 million to construct at the Augusta sewage treatment plant. Primary lime treatment coupled with the existing activated sludge biological treatment system would remove approximately 80% of the phosphorus from the sewage entering the sewage treatment plant, resulting in an effluent concentration of about 2 mg/L. To reduce effluent phosphorus concentration to 1 mg/L or less, additional coagulation and effluent filtration facilities would be necessary. One disadvantage of primary lime treatment, however, would be the two-fold or three-fold increase in sludge to be disposed. Tertiary lime treatment usually results in lower effluent phosphorus levels than primary lime treatment, but the capital cost is significantly higher. Costs for tertiary lime treatment for the Augusta sewage treatment plant would range from \$5 million to \$14 million. The higher estimate would include an additional settling stage and filtration of the effluent, features which would improve the efficiency of phosphorus removal and reduce the effluent phosphorus concentration. (Lantz-PTT)
W90-05183

BIOOXIDATION STUDIES OF POLLUTANTS IN EFFLUENT FROM THE X-710 LABORATORY.

Goodyear Atomic Corp., Piketon, OH. Technical Div. M. J. Greiner, and L. E. Deacon.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-002799. Price codes: A03 in paper copy, A01 in microfiche. Report No. GAT-T-3261, September 30, 1983. 21p, 2 fig, 6 tab, 2 ref. DOE Contract DE-AC05-76OR00001.

Descriptors: *Wastewater analysis, *Wastewater facilities, *Chemical wastes, *Wastewater treatment, *Biological wastewater treatment, *Oxidation, Activated sludge process, Biological treatment, Aerobic treatment, Heavy metals, Organic compounds, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Nickel, Uranium, Zinc, Acetone, Freon, Tetrachloroethylene, Trichloroethylene, Biomass.

Federal Clean Water Act regulations specify requirements which must be met by liquid wastes before they can be discharged to the environment. The Portsmouth Gaseous Diffusion Plant recently built a new sewage treatment facility (X-6619) or greater capacity to replace the original one and

allow processing of sanitary wastewater. The facility uses activated sludge to treat the wastewater. Activated sludge consists of aerobic microorganisms that are sensitive to environmental influences, such as pH, temperature, humidity, and chemicals in the wastewater. These influences could have a toxic effect on the biomass. Therefore, laboratory testing was required to determine if specific wastestreams, which will be processed through the new facility, would kill the activated sludge biomass. The effluent from the X-710 laboratory facility was processed through the original sewage treatment plant with no observable problems. It is now processed through the new treatment plant but this may not satisfy EPA requirements because of possible detrimental effects on the biomass resulting from the presence of toxic pollutants in the waste stream. As determined by extensive analytical characterization, nine heavy metals and five organics were present in possible environmentally unacceptable concentrations. These were As, Cd, Cr, Cu, Fe, Pb, Ni, U, Zn, acetone, Freon-113, isopropyl alcohol, tetrachloroethylene, and trichloroethylene. The metals and organics were tested to determine their effect on the biomass by biooxidation studies that simulated the activated sludge treatment process in the laboratory. One study tested the metals for a two month period, while another study tested the organics for a two-month period. In both cases, the maximum contaminant concentrations observed were used in the tests to ensure worst possible case conditions for study. Results of both studies indicated that no detrimental effect was seen on the biomass at the concentrations tested. Thus, no further testing or investigation of pretreatment technologies for the effluent was required since the laboratory studies show that effluent can be processed through the sewage treatment facility with no toxic effect on biomass. (Author's abstract)
W90-05185

WATER RESOURCES OF SOLEDAD, POWAY, AND MOOSA BASINS, SAN DIEGO COUNTY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div. K. D. Evenson.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4030, 1989. 87p, 20 fig, 28 tab, 24 ref.

Descriptors: *Groundwater, *Wastewater treatment, *Reclaimed water, *Water quality, *California, Geology, Land use, Moosa Basin, Poway Basin, San Diego County, Soil types, Soledad Basin, Surface water, Water use.

Reclaimed water is being considered as a supplemental water supply in the Soledad, Poway, and Moosa basins, San Diego County. This report describes the geology, soils, hydrology, and cultural factors in each of the basins as they relate to use of reclaimed water. Imported water is currently the major water-supply source in the basins. Groundwater supplies are used to a limited extent for both agricultural and domestic needs. Surface water flows are intermittent and, therefore, have not been developed for use in the basins. All three of the basins have the potential for use of reclaimed water, but only the Moosa basin is currently implementing a plan for such use. Concentrations of dissolved solids, chloride, and sulfate in both ground and surface water commonly exceed local basin objectives. As of 1985, plans for use of reclaimed water are oriented toward improving the quality of the groundwater. (USGS)
W90-05274

EVALUATING WATER AND SANITATION PROJECTS: LESSONS FROM IMO STATE, NIGERIA.

For primary bibliographic entry see Field 5F.
W90-05285

PRIMARY HEALTH CARE: WHY HAS WATER BEEN NEGLECTED.

Research Triangle Inst., Durham, NC.
For primary bibliographic entry see Field 5F.

W90-05286

PLANNING AND ANALYSIS FOR WATER REUSE PROJECTS.

California State Water Resources Control Board, Sacramento.
For primary bibliographic entry see Field 3C.
W90-05289

STRUCTURE OF ACTIVATED SLUDGE FLOCS.

Toronto Univ. (Ontario). Dept. of Civil Engineering.
D. Li, and J. J. Gancarczyk.
Biotechnology and Bioengineering BIBIAU, Vol. 35, No. 1, p 57-65, January 1990. 7 fig, 3 tab, 21 ref. Canadian NSERC Grant 7598.

Descriptors: *Activated sludge process, *Histology, *Sample preparation, *Biological samples, Sample preservation, Structure, Microorganisms, Polymers, Microscopic analysis.

Biofloculated microbial aggregates, known as flocs, are the essential components of the activated sludge process. Relatively large activated sludge flocs (larger than about 100 micrometers) were stabilized, using a histological tissue specimen preparation procedure, and then were sliced into sections 3 to 6 micrometers thick. Microscopic study of these sections, after staining, revealed the internal structure of the activated sludge flocs. No uniformity of this structure was found. The distribution of microorganisms and of extracellular polymers (EPs) in the flocs varied randomly on the plane of the sections and along the dimension perpendicular to the plane, leaving large water channels and reservoirs in some of the flocs. The lack of a characteristic size for the water gaps in the flocs and a general self-similar appearance of the sections suggested that the activated sludge flocs might be characterized by the fractal concept within a certain size limit. Direct observation of the interior of the flocs indicated an abundant presence of extracellular polymers in amorphous forms, surrounding microorganisms in most of the flocs. (Author's abstract)
W90-05320

MERCURY ACCUMULATION AND VOLATILIZATION IN IMMOBILIZED ALGAL CELL SYSTEMS.

Lancashire Polytechnic, Preston (England). School of Applied Biology.
S. C. Wilkinson, K. H. Goulding, and P. K. Robinson.
Biotechnology Letters BILED3, Vol. 11, No. 12, p 864-864, December 1989.

Descriptors: *Wastewater treatment, *Mercury, *Biological wastewater treatment, *Algae, *Water pollution treatment, *Separation techniques, Chlorella, Heavy metals, Radiochemical analysis.

Mercury is toxic in its metallic, ionic and organic (monomethyl, dimethyl and phenyl) forms, and has long been recognized as an environmental hazard. More stringent European Community guidelines for the disposal of mercury in wastewaters (1982 to 1984) have made current methods of mercury removal from effluents unsatisfactory. This paper describes studies of the uptake of mercury by free (i.e. non-immobilized) and alginate-entrapped *Chlorella* and its partitioning in the experimental system. Mercury was rapidly removed from the medium by both free and immobilized cells. Immobilized cells removed significantly more mercury ($p > 0.001$) such that less than 1% of the initial mercury added remained after 12 days, compared with about 8% with non-immobilized cells and 98% in the cell-free system. Mercury uptake into free and immobilized cells was rapid, and over 40% appeared in free cells after 12 days and 70% in immobilized cells. Binding of mercury to glassware was minimal and did not exceed 5%, but volatilization from both free and immobilized cells systems was rapid and extensive. Studies show, however, that mercury lost in this way may reen-

ter the aqueous phase and subsequently be accumulated by immobilized cells. (VerNooy-PTT) W90-05321

PROTECTIVE COATINGS AT A WASTEWATER TREATMENT PLANT.

Willow Lake Wastewater Treatment Plant, Salem, OR.

P. Eckley, and T. Plumb.

Public Works PUWOAH, Vol. 120, No. 12, p 73-74, 102, December 1989. 2 tab.

Descriptors: *Coatings, *Wastewater facilities, *Maintenance costs, Project planning, Steel, Concretes, Pipes, Pumps, Scheduling, Future planning, Oregon.

Protecting wastewater treatment plant components with suitable coatings prolong the equipment's useful life and promotes esthetics as well. At the Willow Lake Wastewater Treatment Plant (Salem, OR), a program was started to keep protective coatings maintained at all times using appropriate coating systems for different environments. This is being achieved despite periodic heavy industrial loadings and a rainy season that limits the painting season. Originally built in 1954, the trickling filter plant's protective coatings (paint) were applied with each new plant improvement and maintained by the staff. In 1984 a strategy was planned and developed for coating system improvements and a coating specialist was hired to provide recommendations. Technical specifications were developed in 1985; changes were made to the originally specified coating systems as the projects progressed each year. Four basic systems are now used throughout the plant. These systems cover interior steel piping and pumping equipment, and a system for submerged steel and concrete. Generally, specifications are prepared during winter, bidding and contracts are awarded during spring, and the contract runs from late spring until early fall (start of rainy season). Protective coating systems are summarized, as well as an annual cost summary for 1985 through 1988. Proper ongoing maintenance will ensure that the original investments are maximized and the facility's physical appearance is maintained. (VerNooy-PTT) W90-05328

ALBUQUERQUE'S SEWER REHABILITATION PROGRAM.

Albuquerque's Wastewater Line Maintenance, NM.

R. Pena, and M. S. Holstad.

Public Works PUWOAH, Vol. 120, No. 13, p 61-63, December 1989.

Descriptors: *New Mexico, *Sewer systems, *Rehabilitation, *Pipes, *Construction methods, Maintenance, Sanitary wastewater, Plastics, Linings, Training, Concretes, Albuquerque.

Albuquerque, NM has pursued a concerted sewer rehabilitation program since 1981, making extensive use of sliplining with high-density polyethylene (HDPE) and limited use of Insituform, Expand-A-Line, and push-lining with reinforced plastic mortar (RPM) pipe. Concrete pipe had been used exclusively from the 1940s through 1964, and corrosion of the concrete pipe had been accelerated by biological activity generating sulfuric acid. By the late 1970s, the city faced a serious problem. The only rehabilitation method used to that point had been conventional cut-and-cover pipe replacement. Less costly rehabilitation methods requiring less disruption were needed. In the past 8 years, Albuquerque has rehabilitated and replaced 75 miles of sewers and is developing programs to renew 10 to 20 miles per year. The predominant rehabilitation method used has been sliplining the existing concrete pipe with HDPE, SDR26. In 1983, the city bought equipment and trained the necessary personnel to begin its own sliplining program. In 1987, Expand-A-Line was tested in a city project. In this process, a high-torque boring machine pushes a drilling head through an existing line. The drilling head shatters the existing pipe and pushes it out, followed immediately by a polyethylene liner. Albuquerque will continue using sliplining for the bulk of sewer rehabilitation

where cut-and-cover operations are judged inappropriate and will consider Insituform and Expand-A-Line where their particular advantages offset higher cost. (VerNooy-PTT) W90-05329

WASTEWATER DECHLORINATION OPTIONS.

General Chemical Corp., Parsippany, NJ.

B. Conover.

Public Works PUWOAH, Vol. 120, No. 13, p 57-58, December 1989.

Descriptors: *Dechlorination, *Wastewater treatment, *Chlorination, *Sulfur compounds, *Sodium bisulfite, *Chemical treatment, Sulfur dioxide, Safety, Sulfites, Hazards, Water pollution prevention.

Chlorine use in wastewater treatment plants is required to limit microbial levels in wastewater effluent. Since chlorine can harm aquatic ecosystems, wastewater treatment plants dechlorinate to eliminate residual chlorine. Wastewater treatment systems have traditionally used liquefied sulfur dioxide, because it is cost effective and rapid; however, it is also hazardous and difficult to handle. This paper explores the range of dechlorination options available and focuses on sulfite-based chemicals as an optimal alternative to sulfur dioxide. These chemicals are the best alternative to sulfur dioxide because sulfites equal sulfur dioxide liquid and gas products in dechlorination ability, while using simpler storage and application systems. Sodium bisulfite, the most commonly used compound, is employed in wastewater treatment plants as a 38% solution. Its ability to dechlorinate wastewater has been known for decades, but its first major application began in San Francisco nine years ago. Switching to sodium bisulfite enabled San Francisco to cut its wastewater treatment energy and maintenance costs. Sometimes sodium bisulfite is used in special situations. For example, a sudden cessation in sulfur dioxide availability at Sacramento's Regional Wastewater Treatment Plant (400-mgd) forced the plant to find an immediate alternative. The plant designed, procured, and installed a sodium bisulfite outfall system in only 5 days. The simplicity, safety, low maintenance, and fast response of the new system prompted the plant to install a permanent dechlorination system using sodium bisulfite. Liquid sodium bisulfite use is expected to grow substantially in the next five years. (VerNooy-PTT) W90-05330

INFLUENCE OF TEMPERATURE AND LIGHT INTENSITY ON ACTIVITY OF WATER HYACINTH (EICHORNIA CRASSIPES (MART.) SOLMS).

Ljubljana Univ. (Yugoslavia). Biological Inst.

O. Urbanc-Bercic, and A. Gaberscik.

Aquatic Biology AQOBDS, Vol. 35, No. 3-4, p 403-408, November 1989. 2 fig, 2 tab, 15 ref.

Descriptors: *Wastewater treatment, *Macrophytes, *Phosphorus removal, *Macrophytes, *Tertiary wastewater treatment, *Water hyacinth, *Biological wastewater treatment, Temperature effects, Light intensity, Seasonal variation, Photosynthesis, Effluents.

Aquatic plants are being used more and more to improve the quality of effluents from waste water treatment plants. Therefore, a better understanding of the reaction of the species to inclement conditions is needed. Light and temperature determine the length of the vegetative period of *Eichhornia crassipes* (Mart.) Solms. in temperate climates. Seasonal changes are followed by changes in plant activity. During the summer, the photosynthetic activity was 58.3 milligrams carbon dioxide/g dry weight (DW)/hour. At the end of the growing season, the potential photosynthetic activity (at a temperature of 20°C) decreased to 31.2 milligrams carbon dioxide/g DW/hour. The depression of photosynthetic activity was caused by the decrease in ambient air temperatures. Carbon dioxide assimilation ceased at leaf freezing temperature (-3.5°C in August, -2.3°C in October). Low temperature also influenced phosphorous (P) uptake by water hy-

acinth. At ambient temperatures, the decrease of orthophosphate in effluents was 36.96 milligrams phosphorous/kg fresh weight (FW)/day in August and only 1.62 milligrams phosphorous/kg FW/day at the end of the season. (Author's abstract) W90-05340

USE OF ROOTS TRANSFORMED BY AGROBACTERIUM RHIZOGENES IN RHIZOSPHERE RESEARCH: APPLICATIONS IN STUDIES OF CADMIUM ASSIMILATION FROM SEWAGE SLUDGES.

Institut National de la Recherche Agronomique, Versailles (France). Lab. de Biologie de la Rhizosphère.

For primary bibliographic entry see Field 7B.

W90-05382

ELIMINATION OF DYES IN A MODEL WATER-TREATMENT PLANT (ELIMINIER-BARKETT VON FARBSTOFFEN IN EINER MODELL-KLAERANLAGE).

BASF A.G., Ludwigshafen am Rhein (Germany, F.R.).

C. Randt, K. Taeger, W. Merz, and M. Patsch.

Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 249-252, December 1989. 4 fig, 1 tab, 4 ref. English summary.

Descriptors: *Dyes, *Wastewater treatment, *Dye industry wastes, *Biological treatment, Model studies, Separation techniques.

The elimination behavior of dyes in mechanical biological wastewater treatment plants was examined. An analytical method was developed for determining three typical reactive dyes (Reactive Red 120, Reactive Violet 38, and Reactive Blue 211) in effluent. Solid-liquid extraction to yield an enrichment factor of 10 gave rise to a detection limit of 0.05 milligrams/liter. The dyes were introduced into a model wastewater treatment plant at intervals over 4 hr on 5 subsequent days. The mean elimination rate was approximately 90% for all substances tested. (Author's abstract) W90-05420

MUNICIPAL WASTEWATER RENOVATION BY REVERSE OSMOSIS STATE OF THE ART.

Kuwait Inst. for Scientific Research, Safat.

A. H. Ghabris, M. Abdel-Jawad, and G. S. Aly.

Desalination DSLNAH, Vol. 75, No. 1-3, p 213-240, 1989. 3 fig, 90 ref.

Descriptors: *Reverse osmosis, *Wastewater treatment, *Water reuse, *Tertiary wastewater treatment, Water pollution control, Secondary wastewater, Membranes.

Reverse Osmosis technology has proven to be a technically efficient, cost effective and pollution controlling process for the renovation of different municipal wastewater streams. The application of reverse osmosis technology to renovate municipal wastewater is reviewed. Special emphasis is given to recent process developments, flow sheet configurations, membrane efficiency in reducing effluent TDS, microorganisms, organics, nutrients and others. It is an excellent separation process for the removal of total dissolved solids, a broad range of organics and micropollutants, microorganisms and pathogens, and nutrients. The recent advancements in membrane manufacturing and process hardware have made it possible to produce potable water from secondary municipal effluents that meets World Health Organization (WHO) standards. However, due to ethical and psychological considerations, the product water which is suitable for many industrial, agricultural and other reuse purposes is not recommended for direct human consumption. Although the cost effectiveness of the process for producing large quantities of water (fresh quality) is encouraging, careful preparation of the design specifications is required to suit the particular characteristics of the effluent. Membrane selection, material of construction, pretreatment of the feed, membrane fouling, and brine disposal are the major points to consider before final decisions are made. (Author's abstract)

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

W90-05439

WASTEWATER RECLAMATION AND REUSE IN EUROPE, MIDDLE EAST AND NORTH AFRICA.

International Bank for Reconstruction and Development, Washington, DC. Europe, Middle East and North Africa Technical Dept.
For primary bibliographic entry see Field 3C.
W90-05442

PRE-TREATMENT AND DESALINATION OF MINE DRAINAGE WATER IN A PILOT PLANT.

Coal Union, Katowice, Poland.
For primary bibliographic entry see Field 3A.
W90-05446

REVIEW OF INITIAL THREE YEARS OPERATION OF WASTE WATER MANAGEMENT SCHEME AT 4640MW BAYSWATER/LIDDELL POWER STATION COMPLEX, AUSTRALIA.
Electricity Commission of New South Wales, Sydney (Australia).
J. Stuart, and T. Bryant.
Desalination DSLNAH, Vol. 75, No. 1-3, p 379-393, 1989. 3 fig, 1 tab.

Descriptors: *Australia, *Tertiary wastewater treatment, *Wastewater treatment, *Reverse osmosis, Vapor compression evaporators, Membranes, Design criteria, Alkalinity, Suspended solids.

The 4,640 MW Bayswater/Liddell Power Station Complex waste water management scheme, which incorporates a 149,000 cu m/day alkalinity reduction plant, 35,600 cu m/day reverse osmosis plant and 6,600 cu m/day vapor compression evaporators has completed three years operation. Reverse osmosis plants membrane standard flow and standard salt passage performance have been above design parameters. Only minimal cleaning of reverse osmosis plant membranes has been required as a result of high standards of operation of the plants. Successful operation of the reverse osmosis plants and a high recovery have been achieved. The reverse osmosis loop works in parallel with the suspended solids control alkalinity reduction loop and optimization of operation is achieved by balancing the two loops. The vapor compression evaporators have operated at design capacity with distillate being used as feedwater for demineralizing plant and makeup to cooling towers. Although the technical problems encountered have been significant, acceptable solutions have been found. The major problems have been of a management nature. Not surprisingly, they have arisen from the need to integrate the operation and maintenance requirements of a large complex water treatment system into a management structure designed to operate large power generating plants. Priority setting for operations and maintenance in power generating plant can be readily related to station power output. The water management plant rarely has a direct impact on station loading, hence it was necessary to establish the quantifiable operational targets that enabled logical decision path making for both operations and maintenance staff. (Author abstract)
W90-05447

OXYGEN UTILIZATION IN ACTIVATED SLUDGE PLANTS: SIMULATION AND MODEL CALIBRATION.

Michigan Technological Univ., Houghton.
C. R. Bailord.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-125967.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/600/2-88/065, November 1988.
84p, 18 fig, 26 tab, 22 ref, 2 append. EPA Contract CR813162-01-2.

Descriptors: *Oxygen requirements, *Activated sludge, *Wastewater treatment, *Model studies, Simulation analysis, Dissolved oxygen, Suspended solids.

The objective of the research described in this report is to apply recent advances in activated

sludge process modeling to the simulation of oxygen utilization rates in full-scale activated sludge treatment plants. This is accomplished by calibrating the International Association for Water Pollution Research and Control (IAWPRC) Model and associated SSSP microcomputer software to operating data at six full scale activated sludge treatment plants. Field data were used to calibrate the key biological parameters contained in the model so that the oxygen utilization rates, dissolved oxygen concentrations, mixed liquor volatile suspended solids concentrations, and process performance simulated by the model matched the corresponding quantities observed in the treatment plants. The results showed that the model and associated software package provide a useful capability to analyze, simulate, and predict oxygen utilization rates. It was possible to obtain reasonable agreement between the measured and simulated values of oxygen uptake rate, dissolved oxygen concentration and other process parameters at most of the plants studied. The key model parameters were the heterotrophic yield coefficient, heterotrophic decay constant, and autotrophic maximal specific growth rate constant. (Author's abstract)
W90-05558

PRELIMINARY RESULTS OF AN EXPERIMENT TO ASSESS THE EFFECT OF SUBSTRATE TYPE ON TREATMENT OF ACID DRAINAGE USING CONSTRUCTED WETLANDS.

Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5C.
W90-05559

ANAEROBIC TREATMENT OF INDUSTRIAL WASTEWATERS.

Noyes Data Corporation, Park Ridge, New Jersey.
1988. Pollution Technology Review No. 154.
Edited by Michael F. Torpy. 122p.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Wastewater treatment, *Biological wastewater treatment, Technology, Biogas, Economic aspects.

The technology of anaerobic digestion has developed significantly in recent years. One important aspect is the land cost saved by installing an anaerobic reactor instead of using an aerobic activated sludge process. The most recent and significant advances in anaerobic digestion are related to the technology's ability to accommodate relatively high rates of organic loading. Companies are also interested in using anaerobic digestion for the biodegradation of organic materials that are not removed in conventional aerobic treatment. The state of the art in treatability testing is relatively simple. An anaerobic culture is mixed with the substrate in the presence of micronutrients. Usually, the air of the testing vessel is replaced with a mixture of carbon dioxide and nitrogen gas and the vessel is sealed to prevent contamination by ambient air. The activity of the bioprocess is monitored by measuring the quantity and quality of biogas produced. Because the technology has been applied to a relatively limited array of waste types, caution should be exercised in drawing conclusions from results of a negative assay. The appropriate source of a culture often makes the difference between a successful assay and a failure to produce methane. The contributions in these proceedings present some information not previously available, and indicate the favorable as well as unfavorable aspects of the technology. (See W90-05564 thru W90-05580) (White-Reimer-PTT)
W90-05563

ADVANCES IN ANAEROBIC BIOTECHNOLOGY FOR INDUSTRIAL WASTEWATER TREATMENT.

Drexel Univ., Philadelphia, PA. Dept. of Environmental Engineering.
R. E. Speece.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 1-6. 3 ref. Argonne

National Laboratories Contract 31-109-38-7196 and EPA Grant R-810633-01-0.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Biological wastewater treatment, *Industrial wastes, Cell immobilization, *Anaerobic filters, Culturing techniques, Nutrients.

Anaerobic biotechnology for industrial waste treatment is steadily expanding in the U.S. and abroad. The key role of cell immobilization has been recognized and the anaerobic upflow filter, upflow anaerobic sludge blanket (UASB) and fluidized bed unit processes have evolved. Recently, hybrids of these first two processes have emerged to capitalize on the positive features of each. Volumetric loading rates of approximately 2 to 4 kg/cu m/d characteristics of the anaerobic contact process to 10 to 20 kg/cu m/d for the UASB. One short term loading rate of 125 kg/cu m/d was observed with a fluidized bed using a paper mill condensate wastewater. With the improvement in cell immobilization for unit processes for wastewaters comprised mainly of soluble organic pollutants, hydrolysis is often not rate limiting and conversion of volatile acids and hydrogen to methane becomes rate limiting. Laboratory studies using continuous cultures of methanogens converting acetate to methane have shown very significant stimulation resulted from supplementation with specific nutrients. The predominant population shifted from the slower growing, lower activity Methanotrix to the faster growing, higher specific activity Methanosarcina subsequent to the supplementation of iron, cobalt, nickel and trace levels of vitamin B12. Generation times were reduced and acetate utilization rates were markedly increased. Acetates utilization rates of 35 kg/cu m/d were noted at solids retention times of as low as 5 days. (See also W90-05563) (Author's abstract)
W90-05564

ANAEROBIC TREATMENT OF PHARMACEUTICAL FERMENTATION WASTEWATER.

Abbott Labs., North Chicago, IL.
W. M. Robertson, and R. E. Green.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 7-14. 1 fig, 7 tab, 1 ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Wastewater treatment, *Biological wastewater treatment, *Pharmaceutical wastes, Suspended solids, Chemical oxygen demand, Anaerobic filters, Antibiotics.

The anaerobic degradation of pharmaceutical antibiotic fermentation wastewaters was studied at pilot scale, and a system was selected for full scale implementation. The waste contained a high proportion of suspended solids which represented about 40% of the COD, as well as residual amounts of antibiotics, extraction solvents, grain flours, sugars, protein and nutrients. Four treatment configurations were piloted: a downflow anaerobic filter, a downflow/upflow anaerobic filter, an upflow anaerobic sludge blanket, and a low rate anaerobic reactor. The high rate systems were ultimately incapable of assimilating the feed suspended solids, resulting in excessive loss of biomass and, therefore, low soluble COD removals. The low rate system adequately hydrolyzed the feed solids and yielded 70% COD and 80-90% TSS removals. The presence of antibiotic residuals did not affect the system. A full scale low rate reactor system was designed and is planned for startup in August, 1987. (See also W90-05563) (Author's abstract)
W90-05565

ANAEROBIC TREATMENT FOR PULP AND PAPER WASTEWATERS.

Environmental Canada, Wastewater Technology Centre, Burlington, Ontario Canada.
E. R. Hall, H. Melcer, L. A. Cornacchio, and R. M. Jones.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 15-22. 3 fig, 5 tab, 7 ref.

Waste Treatment Processes—Group 5D

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Industrial wastes, *Pulp and paper industry, Canada, Chemical oxygen demand, Biological oxygen demand, Wastewater reactors.

Anaerobic technology has been gaining acceptance as a cost-effective treatment alternative for wastewaters produced in the pulp and paper industry. Potential applications for anaerobic treatment are being delineated by an extensive laboratory scale screening study of several Canadian pulp and paper wastewaters. These testing procedures estimate the level of COD and BOD removal achievable anaerobically, as well as the effects of inhibitory wastewater components on anaerobic microorganisms. Results of a pilot scale comparative assessment of several commercial anaerobic systems are reviewed along with data illustrating the effects of dynamic operating conditions on the stability of high rate anaerobic processes. For the upflow anaerobic sludge blanket reactor (UASB) the design loading rate of 10 kg/cu m/d was reached after one month of operation. Under all loading rates examined the target BOD removal rates of 80% were exceeded. Pulp and paper effluents contain variable amounts of materials that are toxic or inhibitory to microorganisms in a biological treatment plant. The effects of these time-varying factors can be mediated partially by altering process designs to include adequate equalization, recycle and bypass capability. Operating strategies can also be optimized with on-line monitoring and control systems that can respond to process stress by manipulating a number of system variables. (See also W90-05563) (White-Reimer-PTT)
W90-05566

ANAEROBIC WASTEWATER TREATMENT OF A FUEL ETHANOL FACILITY.

Ashland Petroleum Co., KY.

R. L. Gross, and J. Lanting.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 23-34. 3 fig, 3 tab, 4 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, Industrial wastes, *Alcohols, Ohio, Pretreatment, Chemical oxygen demand, Costs.

In an effort to consistently meet an existing NPDES permit, a corn to fuel grade ethanol producer in southeastern Ohio recently installed a high rate anaerobic wastewater treatment system. This plant uses the upflow sludge blanket technology to pretreat process wastewater. The effluent from the anaerobic system is polished in a two-stage bio-tower prior to discharge to the Ohio River. Based on a pilot study and the initial implementation of the plant the following conclusions were reached: (1) significant biomass addition was essential for an accelerated start-up; (2) during the performance test the pretreatment system on average reduced the wastewater SCOD from 5348 mg/L to 281 mg/L, a removal efficiency of 95%, at volumetric loadings ranging from 7.9 to 21.7 kg SCOD/cu m/d; (3) the anaerobic system demonstrated its ability to accept large fluctuations in loading, without a detrimental effect on the performance; (4) the cost of operating this pretreatment facility is approximately 13 cents per kg of SCOD removed; and (5) the anaerobic technology tested appears to be ideally suited for pretreatment of wastewater generated at an ethanol facility or from similar industries. (See also W90-05563) (Author's abstract)
W90-05567

MICROBIAL ASPECTS OF ANAEROBIC DIGESTION.

Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.

A. Wilkie, and E. Colleran.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 35-48. 1 fig, 2 tab, 75 ref.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Biological wastewater treatment, *Microbial degradation, Monitoring, Sludge, Biomass, Microorganisms, Digesters.

Aspects of the microbiology of anaerobic digestion and the importance of interspecies reactions in the operation and control of anaerobic reactors are reviewed. Topics discussed include: (1) microbial interactions; (2) monitoring and process controls; (3) effective biomass measurement; (4) biomass activity measurements; (5) anaerobic biofilm formation; (6) sludge granulation; (7) micronutrient effects; and (7) biomass characterization. Advances in the understanding of the complex microbiology of the anaerobic digestion process are providing new insights into microbial interactions and into factors governing the dominance, activity and maintenance of individual species in digester mixed liquors, biofilms and granules. It is expected that the use of monoclonal antibody probes to identify the methanogen immunotypes will prove promising for genetic engineering manipulation. Cloning studies have already been successful in obtaining expression of functional methanogen gene products in *Escherichia coli* and *Bacillus subtilis*. (See also W90-05563) (Author's abstract)
W90-05568

REACTOR DESIGN CONSIDERATIONS AND EXPERIENCES WITH VARIOUS WASTEWATERS.

Grontmij Consulting Engineers, De Bilt (Netherlands).

T. J. M. Jans, and G. de Man.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 49-68. 12 fig, 11 tab, 3 ref.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Biological wastewater treatment, *Industrial wastes, Pretreatment, Case studies, Design criteria, Organic loading.

During the last decade a great number of high-rate anaerobic treatment plants were built and put into operation for the (pre)treatment of mainly industrial wastewaters. The breakthrough in anaerobic technology for relatively diluted wastes (water content over 95%) resulted from the development and successful application of new, simple and relatively inexpensive anaerobic treatment processes. A selection of reactor design considerations of the upflow anaerobic sludge blanket process (UASB) are evaluated based on experience with several full-scale plants presently in operation, as well as on laboratory and pilot-plant research. The main elements of the reactor are the influent distribution system in the bottom of the reactor, and a three-phase separator (gas, solids, liquid) at the top. The attainable loading of any biological system depends on the amount of active sludge in that system and its capability for retaining the sludge under the required process conditions. In full-scale reactors, sludge concentration of 10-20% are common for the sludge bed (approx 1/3 of reactor volume) which, together with specific sludge activities of 0.5-2.0 g COD/(g VSS/d), gives the reactor an enormous potential in respect to its metabolic activity. The main condition to be fulfilled in the design of the three-phase separator is the accomplishment of an effective separation of the gas before the water/solids mixture reaches the settling zone of the reactor. Case studies are presented for a cheese factory, a wheat industry, a maize starch factory, leachate from a sanitary landfill, and a liquorice factory. Results show it is possible to achieve a large degree of process stability at minimum investment and operational costs. (See also W90-05563) (White-Reimer-PTT)
W90-05569

ANAEROBIC MARKETING-THREE CASES IN POINT.

Bioenergy Systems Ltd., Milwaukee, WI.

E. A. Richards.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 69-78.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Industrial wastes, *Marketing, Legal aspects, Economic aspects, Insurance.

Three BSL/Robex/Grontmij UASB (Upflow Anaerobic Sludge Blanket) dairy industry marketing projects of the recent past are described, along with some problems encountered during the marketing phase. These proposed projects, in order of submission, included the following: (1) A UASB system only, releasing effluent to a large municipal plant; (2) A UASB system with high-level aerobic post-treatment for release of effluent to a small-town municipal plant; (3) A UASB system with high-level aerobic post-treatment to bring BOD and TSS to under 20 mg/L for direct release to the environment. Along with the present status of the above three projects, some of the specific problems arising from the liability, pricing, bacteriological, and legal aspects of these types of projects are analyzed, with some limited recommendation for the problem approach. It is suggested that anaerobic systems vary in terms of method, time, and efficiency. Therefore, the marketer should be careful in estimates and accuracy should be stressed regarding the potential return on the system. Client and sales interests should be protected by making certain the project agreement spells out terms in an exact fashion, and states precisely the conditions of sale. (See also W90-05563) (Author's abstract)
W90-05570

MONSANTO PERSPECTIVE ON ANAEROBIC TREATABILITY OF INDUSTRIAL WASTES.

Monsanto Co., St. Louis, MO.

W. E. Gledhill, E. G. Valines, and M. F. Weishaar.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 79-85. 1 fig, 3 tab, 9 ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, Biological wastewater treatment, Methane, Toxic wastes, Case studies.

Results of various research projects concerning anaerobic treatment of different Monsanto industrial wastewaters is summarized. Experiences from studies that attempted to apply anaerobic technology to process effluents have resulted in no workable solutions to date. Problems include excessive ammonia production from denaturation, excessive TDS interfering with normal sludge growth, and recalcitrant organics toxic to microorganisms. In the cases where removal of specific compounds were examined, anaerobic treatment was either ineffective or results were not definitive. In some cases methane production was low. The lack of success is probably attributable to the fact that the wastes examined are in the 'hard to treat' category. A combination of chemical and biological (anaerobic) treatment may provide suitable treatment for hard to treat wastes now disposed of by non biological means. (See also W90-05563) (Author's abstract)
W90-05571

INDUSTRIAL-SCALE ANAEROBIC TREATMENT OF YEAST FERMENTATION WASTEWATER.

Biothane Corp., Camden, NJ.

D. A. Johnston.

IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 86-89. 1 fig, 1 tab.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Industrial wastes, Biochemical oxygen demand, Chemical oxygen demand, Pretreatment, Yeast fermentation wastes.

The BIOTHANE high-rate anaerobic process has been in continuous operation at two bakers yeast manufacturing facilities for a cumulative total of nearly four years. The anaerobic system is used as a primary step in the treatment of wastewater originating from several different molasses fermentations.

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tation streams. At one facility the anaerobic effluent is discharged directly to the municipality, while at the other facility the anaerobic effluent is first polished for ammonia removal in a secondary activated sludge system and then discharged to the municipality. Excellent operating results have been attained at both facilities. BOD purification efficiencies of 85% to 95% at volumetric loading rates of 10 to 14 Kg COD/cu m of digester volume/day are routinely achieved. The manufacturing facilities have gained economic advantages by pretreating the wastes anaerobically. (See also W90-05563) (Author's abstract)
W90-05572

ANAEROBIC SEQUENCING BATCH REACTOR TREATMENT OF COAL CONVERSION WASTEWATERS.

Notre Dame Univ., IN. Dept. of Civil Engineering.
J. P. Earley, and L. H. Ketchum.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 90-93. 1 fig, 1 tab.
DOE, Pittsburgh Energy Technology Center Grant DE-FG22-85PC80512.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Wastewater treatment, *Industrial wastes, *Coal wastes, Pilot studies, Phenols, Suspended solids, Reactors.

A continuing laboratory study is being conducted to try to develop both an operating strategy and a design for Anaerobic Sequencing Batch Reactors (AnSBR) for biological treatment of coal conversion wastewaters. The project is in the early stages and the results reported are based on only several months of investigation. The laboratory studies are being conducted in three different size reactors. The smallest are 150-mL serum bottles that are being used to screen individual coal conversion wastewater constituents. Several constituents have been shown to be degraded under anaerobic conditions. Six 2-L AnSBR's are being operated to acclimate anaerobic sludges (i.e., organisms) to mixtures of these constituents. Finally, two automatically operated, 4-L AnSBR are being used to treat a synthetic coal conversion wastewater currently consisting of phenol, (the only carbon source) and vitamins and minerals. After only one and one-half months of operation, phenol degradation is almost complete, no pH adjusting chemicals are added and effluent suspended solids concentrations are improving and have reached 50 mg/L. (See also W90-05563) (Author's abstract)
W90-05573

POTENTIAL FOR ANAEROBIC TREATMENT OF HIGH SULFUR WASTEWATER IN A UNIQUE UPFLOW-FIXED FILM-SUSPENDED GROWTH REACTOR.

Sydlo, Inc., Mississauga (Ontario).
L. S. Love.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 94-97.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Wastewater treatment, *Industrial wastes, Sulfur, Pretreatment, Pulp and paper industry, Biogas.

Anaerobic degradation is ideally suited for the pretreatment of high strength industrial effluents. However, many wastes, particularly those from the Pulp and Paper Industry, may contain substantial amounts of sulfur. This will result in sulfide toxicity and inhibit anaerobic degradation. An obvious solution would be to reduce the soluble sulfide concentration within the reactor, to a point below the 'threshold limit'. This can be done in the Sydlo Anaerobic Reactor, by rapid removal of biogas. A unique design feature of the Sydlo Anaerobic Reactor makes it possible to remove large volumes of supernatant, including biogas containing hydrogen sulfide (H₂S), from the reactor at two intermediate points. This recycle flow, which can be very high, is directed to external gas separators where the biogas (and H₂S) are removed. The supernatant, less biogas (and H₂S), is then returned

to the reactor. The basic advantage of this process is a substantial reduction in operating costs due to: (1) elimination of ferric chloride addition; (2) lower sludge disposal costs; and (3) possible recovery of sulfur from H₂S gas. (See also W90-05563) (Author's abstract)
W90-05574

HIPERION PROCESS: AN ADVANCED METHOD OF HYDROGEN SULFIDE REMOVAL FROM BIOGAS.

Ultrasystems, Inc., Irvine, CA.
J. Yu.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 98-102. 1 fig.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Wastewater treatment, *Biogas, *Hydrogen sulfide, Hiperon process, Takahax Process, Catalysts, Economic aspects, Oxidation-reduction, Sulfur.

An anaerobic treatment system was developed that is an effective alternative catalytic oxidation/reduction process that converts hydrogen sulfide directly to elemental sulfur without the use of heavy metals or other hazardous chemicals. The Hiperon process is an improved version of the Takahax process. Hiperon makes use of a naphthaquinone chelate, which permits a high oxidation rate resulting in a significant reduction in reaction residence time compared with the Takahax process. The high redox potential of the Hiperon catalyst provides for high chemical reactivity with hydrogen sulfide to form elemental sulfur. This results in a high throughput rate. The catalyst is also completely selective to hydrogen sulfide, even in an acid gas with high CO₂ concentrations. The process is not sensitive to the operating pressure and temperature of the system. Where low or high feed gas temperature is dictated, solvents other than water may be used. A wide range of solvents including alcohols, glycols, and glycerins can be accommodated by the process. The catalyst is not consumed in the reactions, but is regenerated with air and its performance does not deteriorate over time. The system results in a simple desulfurization process characterized by a lower solution circulation rate and a more efficient, yet compact plant that provides savings in capital and operating costs. (See also W90-05563) (White-Reimer-PTT)
W90-05575

DORR-OLIVER'S EXPERIENCE WITH ANAEROBIC TREATMENT OF INDUSTRIAL WASTEWATERS.

Dorr-Oliver, Inc., Stamford, CT.
P. M. Sutton, and T. W. Bezler.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 103-106. 4 fig, 3 tab.

Descriptors: *Biological wastewater treatment, *Anaerobic digestion, *Wastewater treatment, *Industrial wastes, Fluidized beds, Membrane filters, Food-processing wastes, Pulp and paper industry.

The Anitron system is a highly efficient anaerobic wastewater treatment process which utilizes a fluidized bed reactor. Within the reactor, a fixed-film of microbial growth (supported growth) occurs on the media (usually sand), which is hydraulically supported as a fluidized bed by the incoming wastewater and recycled effluent. Wastewaters with BOD levels of 2000 mg/L or more, such as found in the food, beverage, and pulp and paper industries, are candidates for treatment with this technology. A suspended growth-or contact-reactor is coupled with ultrafiltration membrane modules which serve to completely retain system biomass and provide an effluent that is essentially free of suspended solids. Tables and figures are presented that summarize the performance of the system for grain, pulp and paper, and corn processing wastes. (See also W90-05563) (White-Reimer-PTT)
W90-05576

HYAN PROCESS TREATS HIGH STRENGTH WASTEWATER AND GENERATES USABLE ENERGY.

G.S. Process, Inc., Scottsdale, AZ.
D. W. Hein, and G. V. Crawford.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 107-110.

Descriptors: *Biological wastewater treatment, *Anaerobic digestion, *Wastewater treatment, *Industrial wastes, HYAN Process, Biogas, Methane, Economic aspects.

The HYAN Process hybrid anaerobic process was developed to effectively treat the high strength waste from a thermal conditioning process, and to generate a continuous and reliable supply of gas energy. The HYAN process consists of a unique hybrid configuration combining anaerobic suspended growth and fixed film filter technology. The facility has consistently achieved 72% COD and 80% BOD reductions, while producing between 10,000 and 14,000 cubic meters of fuel gas per day. The reduced load to the aerobic facility has lowered the overall electrical treatment costs. In addition, the methane produced has replaced most of the natural gas requirements of the thermal conditioning process. The reduced loading on the aerobic system has deferred major capital expenditures for new tankage and aeration systems until increased sewage flows justify plant capacity. The HYAN system has also reduced the quantity of solids requiring treatment and disposal, by efficiently converting the organic pollutants to gas. (See also W90-05563) (White-Reimer-PTT)
W90-05577

BIOSULFIX: AN ANAEROBIC TREATMENT PROCESS FOR HIGH SULFATE WASTEWATERS AND SLUDGES.

Duncan, Lagnese and Associates, Inc., Pittsburgh, PA.
G. R. Gillespie, and M. Olthoff.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 111-113. 10 ref.

Descriptors: *Biological wastewater treatment, *Anaerobic digestion, *Desulfurization, *Wastewater treatment, Sulfates, Sulfur bacteria, Biogas.

In an anaerobic reactor, the sulfate reducing bacteria (SRB) reduce sulfates to sulfides that can create a toxic environment for the methane forming bacteria (MFB). The sulfides produced end up in the bio-gas formed by the anaerobic reactor. The sulfides present cause corrosion problems and odors. A laboratory feasibility study was conducted for Lakeland, Florida to determine the feasibility of mixing the undigested sludge from the municipal sewage plant with the flue gas desulfurization (FGD) sludge from the power plant. The objective was to first digest the organics in the sludge so that the residual organic sludge can be used for land disposal, while at the same time the sulfur in the gas is recovered as sodium bisulfide that can be sold to various industries including the pulp and paper industry. Based on the pilot study, the 'BIO-SULFIX' system was applied to a full scale facility. The overall performance of the 'BIO-SULFIX' system was marginal with respect to SOC/BOD removal. BOD removal was 50% on the pilot plant versus 85% in the lab scale reactors. The poor performance of the pilot plant was due to the variable nature of the waste. Another contributing factor was the length of the pilot study. The small scale laboratory reactors were operated over a period of two years. The pilot plant did not have adequate time to develop its full biomass potential in the six-month study. (See also W90-05563) (White-Reimer-PTT)
W90-05578

CELROBIC PROCESS—PERFORMANCE STABILITY.

Badger Engineers, Inc., Cambridge, MA.
A. M. Sobkowicz.
IN: Anaerobic Treatment of Industrial

Ultimate Disposal Of Wastes—Group 5E

Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 115-118. 3 fig, 4 tab.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Industrial wastes, *Wastewater treatment, Packed beds, Celrobic Process, Wastewater reactors, Solids.

The Celrobic high-rate anaerobic treatment process was developed by the Celanese Chemical Company, and is currently being used commercially in nine installations in Texas, Japan, and Wisconsin. The upflow random packed-bed configuration accounts for the reliability and stability of the process. Methods have been developed for stripping accumulated solids from the reactor internals in order to prevent plugging the system. The removal efficiency for one of the systems tracks the void volume closely, illustrating that a relatively high void volume seems to promote better removal. However, a high inventory biomass (low void volume) is thought to produce a more stable system for difficult wastes (i.e., wastes that are highly variable or that contain toxins). The long-term continuous performance relies on the ability to measure and control the quantity of solids that remain in the reactor. Industries successfully using this system include: guar bean processing, petrochemical, wheat starch, food-fermentation, slaughter house, piggy, and food processing. (See also W90-05563) (White-Reimer-PTT) W90-05579

ANAEROBIC TREATMENT OF INDUSTRIAL WASTES.

Argonne National Lab., IL. Energy and Environmental Systems Div.
A. S. Ng, C. M. Rose, and M. F. Torpy.
IN: Anaerobic Treatment of Industrial Wastewaters. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 119-122. 2 tab, 1 ref. DOE Conservation and Renewable Energy, Industrial Waste Products Utilization Programs Contract kW-31-109-Eng-38.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Industrial wastes, *Wastewater treatment, Chemical oxygen demand, Sludge solids, Organic compounds, Reactor design, Microbial degradation.

Anaerobic biological waste treatment of industrial wastes offers advantages over aerobic systems in terms of lower energy requirements, less biological sludge production, and the potential for energy recovery in the form of methane gas. The development of innovative reactor designs, based on the optimization of growth and retention of anaerobic microorganisms, has created an impetus to reevaluate the anaerobic treatability of many industrial waste streams. The objective of the Industrial Waste Research Laboratory (IWRL) is to examine anaerobic treatability of industrial wastes, particularly those process-wastes originating from the Organic Chemical Production Industry. At the bench-scale testing level, COD removal efficiencies exceeding 85%, at organic loadings of 10 g COD/L/d or greater, were observed for several Organic Chemical Production process wastes. Some of these process-wastes required only simple neutralization and alkalinity supplementation to ensure high-rate treatability and process stability. Other process-wastes were found to be unsuitable for anaerobic treatment because of the presence toxic or inhibitory materials. Important factors which may determine the potential for high-rate treatability include the choice of reactor/process configuration, pre-treatment and/or co-treatment conditions, nutrient supplementation, and microbial acclimation ability. (See also W90-05563) (White-Reimer-PTT) W90-05580

EPA TREATABILITY DATABASE.

Radian Corp., Milwaukee, WI.
S. A. Hansen, C. Crosby, and K. A. Dostal.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129399. Price codes: A03 in paper copy, A01 in microfiche. Report EPA/600/D-88/244, November 1988. 11p, 8 fig.

Descriptors: *Wastewater treatment, *Databases, Organic compounds, Inorganic compounds, Industrial wastewater, Domestic wastes, Groundwater quality, Leachates, Surface water.

Since the mid-1970s the US EPA has generated a wealth of data on the treatability of organic and inorganic compounds found in industrial and domestic wastewaters, groundwater, leachates, and surface waters. To date, various attempts have been made to organize selected segments of this information, but a comprehensive evaluation and compilation of information encompassing compounds regulated by all pertinent environmental laws has not been undertaken. This major activity was initiated with the overall objective of providing a database on the treatability of priority pollutants and other hazardous compounds in water and wastewater. The database summarizes years of studies on the treatability of priority pollutants and other hazardous compounds. The database will allow the user to have access to published, peer-reviewed, technical literature to assist in determining whether a proposed method of treatment is appropriate for the specific compound present in the waste/water to be treated. All information within the database can be accessed by identifying the compound of concern. A compound name can be selected in three ways; name can be selected from the compound listing, compound name can be typed in, or the CAS (Chemical Abstract Service Registry) number is typed in. The listing includes many of the common synonyms for each compound. Therefore, the user need not now the exact name under which the compound was stored in the program; but can use the name that is most familiar. (Author's abstract) W90-05588

STATUS OF US EPA'S SLUDGE INCINERATOR REGULATIONS.

Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G. W90-05590

APPLICATION OF THE 'MASTER ANALYTICAL SCHEME' TO INFLUENT AND EFFLUENT WASTEWATERS.

Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5A. W90-05591

5E. Ultimate Disposal Of Wastes

PLUTONIUM DISTRIBUTION AND OXIDATION STATES IN A REACTOR LEACHING PONDS SYSTEM.

Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology.
For primary bibliographic entry see Field 5B. W90-04558

PHOSPHORUS-31 MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE OF WASTEWATER SLUDGES AND SLUDGE-AMENDED SOIL.

Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5A. W90-04619

SOLUBILITY AND PHOSPHORUS-31 MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE OF PHOSPHORUS IN SLUDGE-AMENDED SOILS.

Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5B. W90-04620

ROLE OF FUNGI IN STABILIZING AGGREGATES OF SEWAGE SLUDGE AMENDED SOILS.

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
R. S. Kinsbursky, D. Levanon, and B. Yaron.

Soil Science Society of America Journal SSSJD4, Vol. 53, No. 4, p 1086-1091, July/August 1989. 3 fig, 4 tab, 31 ref.

Descriptors: *Soil amendments, *Soil aggregates, *Soil fungi, *Soil bacteria, *Soil stabilization, *Sludge disposal, Fungi, Soil physical properties, Soil chemistry.

The effect of sludge amendment on the percentage of water-stable aggregates (WSA) of five soils with different physical and chemical properties was studied in an incubation experiment. A 5% sludge addition to soil incubated at 25 C increased the percent of WSA after 30 d in all of the soils. Bactericides were added to soil-sludge mixtures to assess the role of fungi in the aggregation process. Bactericide addition resulted in the suppression of bacterial growth and a concomitant proliferation of fungal hyphae. The WSA was highly correlated with water-soluble carbohydrates in all of the soils, and with hyphal length in two loessial soils. This suggests that cementing by fungal carbohydrates is a relatively more important binding mechanism than physical entanglement by mycelium in WSA formation of sludge-amended soils. By using a soil washing technique, it was determined that fungi involved in stabilizing aggregates were indigenous soil saprophytes that replaced the native sludge fungal flora. (Author's abstract) W90-04621

GROWTH POTENTIALITIES OF THE GIANT TROPICAL PRAWN, MACROBRACHIUM ROSENBERGII (DE MAN), IN WASTE-HEAT DISCHARGE WATERS OF A THERMOELECTRIC POWER STATION.

Akademiya Navuk BSSR, Minsk. Inst. of Zoology.
For primary bibliographic entry see Field 8I. W90-04637

TOXICOLOGICAL ASPECTS OF ACTIVATED SLUDGE FEEDING.

Agricultural Research Organization, Bet-Dagan (Israel). Dept. of Animal Nutrition.
For primary bibliographic entry see Field 5C. W90-04683

SEQUENCING BATCH REACTOR ACTIVATED SLUDGE PROCESSES FOR THE TREATMENT OF MUNICIPAL LANDFILL LEACHATE. REMOVAL OF NITROGEN AND REFRACTORY ORGANIC COMPOUNDS.

National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 5D. W90-04737

BIOPHYSICAL TREATMENT FACILITY FOR HAZARDOUS WASTE LANDFILL LEACHATES.

BKK Corp., West Covina, CA. Landfill Div.
For primary bibliographic entry see Field 5D. W90-04738

ROLE OF SULFATE-REDUCING BACTERIA IN THE ESTABLISHMENT OF THE METHANOGENIC PHASE OF REFUSE STABILIZATION.

Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
J. A. M. V. van Esch, A. L. Williams, W. J. Jones, W. H. Cross, and F. G. Pohland.
Water Science and Technology WSTD4, Vol. 21, No. 12, p 1689-1691, 1989. 2 fig, 1 ref.

Descriptors: *Water quality control, *Water pollution prevention, *Waste disposal, *Landfills, *Anaerobic digestion, *Bacteria, Digestion, Sulfur bacteria, Methane bacteria, Sulfates, Lysimeters.

Methanogenic bacteria and/or sulfate-reducing bacteria were added to laboratory-scale lysimeters containing fresh municipal solid refuse mixed with a small volume of sediment. Gas production was established most rapidly in the columns to which both types of bacteria were added. (Cassar-PTT)

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W90-04747

DETENTION TIME DISTRIBUTION OF SLUDGE IN RECTANGULAR SECONDARY SETTLERS.

Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering. D. J. Lumley, and G. Horkeby. Water Science and Technology WSTED4, Vol. 21, No. 12, p 1763-1766, 1989. 1 fig, 3 tab, 5 ref.

Descriptors: *Secondary wastewater treatment, *Wastewater treatment, *Activated sludge, *Sedimentation, Sludge thickening, Dewatering, Retention time.

The performance of the secondary settlers often determines the effluent quality of secondary wastewater treatment plants and is generally the capacity limiting factor for the process. A study was conducted to identify how long and where sludge is located in a settler and what implications this has on settler design and operation. The detention time distribution of sludge in rectangular secondary settlers was measured in a full-scale wastewater treatment plant, using manganese as a tracer. The settler sludge retention time increased rapidly with an increasing degree of thickening in the settler. The hydraulic retention time measurements indicated that the apparent efficiency of the settlers increased with increased sludge blanket depth. It was recommended that the secondary settler should not be used for thickening if it is prone to upsets. (Cassar-PTT) W90-04765

PRODUCTION OF PROTEIN FOR ANIMAL FEED STUFF USING ORGANIC WASTEWATERS FROM WINE DISTILLERIES.

Forschungsinstitut fuer Wassertechnologie e.V., Aachen (Germany, F.R.).

For primary bibliographic entry see Field 5D. W90-04788

COMPUTER PROGRAM FOR FARM WASTE MANAGEMENT.

West of Scotland Agricultural Coll., Auchincruive. Dept. of Microbiology.

For primary bibliographic entry see Field 5D. W90-04791

FATE OF METALS LINKED WITH SEWAGE SLUDGES OR MUNICIPAL REFUSES USED AS IMPROVEMENTS IN MARKET GARDENING.

Ministère des Transports, Nantes (France). Service des Etudes, de la Recherche et de la Technologie. B. Berthet, J. C. Amiard, C. Amiard-Triquet, C. Maillet, and C. Metayer.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1917-1920, 1989. 2 fig, 2 tab, 8 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Agriculture, *Sludge disposal, *Land disposal, Waste disposal, Soil contamination, Copper, Lead, Soil amendments, Cadmium, Zinc, Metals, Vegetable crops, Groundwater pollution.

Sewage sludge was applied to 7 vegetable crops in several treatment schemes during 1980 to 1986 to study the fate of metals derived from the sludge. The comparison of metal levels in controls and in vegetables grown on soils improved with different types of organic wastes did not show any significant differences. The accumulation of individual metals depended on the species, except for copper, the level of which varied slightly. The highest concentration of Cd was in lettuce, celeriac and celery; lead in leaves of carrot, celery and corn salad; Zn in lettuce, corn salad, celeriac and celery. The levels of Cd and Pb were influenced by mode of culture, open air culture producing higher levels than greenhouse culture. In soils, Cd and Cu levels were higher at the end of the experiment. Greatest increases were seen in soils treated with a compost based on refuse or with compost consisting of municipal refuse mixed with sludge. The metals contents of the treatment substances were too low to account for the metals buildup; it was postulated

that the organic matter in the compost contributed to the binding of metals. The balance of metals inputs from all sources versus the outputs with the vegetables showed the potential for migration into the ground-water. (Cassar-PTT) W90-04803

THERMOPHILIC PROCESS FOR PROTEIN RECOVERY AS AN ALTERNATIVE TO SLAUGHTERHOUSE WASTEWATER TREATMENT.

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).

For primary bibliographic entry see Field 5D. W90-04861

UTILIZATION OF AGRO-INDUSTRIAL RESIDUES IN ALEXANDRIA: EXPERIENCE AND PROSPECTS.

Alexandria Univ. (Egypt). Higher Inst. of Public Health.

A. Hamza. Biological Wastes BIWAED, Vol. 29, No. 2, p 107-121, 1989. 2 fig, 2 tab, 12 ref.

Descriptors: *Waste utilization, *Waste recovery, *Egypt, *Industrial wastes, Treatment facilities, Economic aspects, Environmental effects.

About 120,000 tons of agro-industrial residues are generated annually in Alexandria, Egypt, part of which is used for the production of animal feed, soil conditioners and other uses as secondary products. However, the lack of an organized system for collection and storage and the absence of incentives for reutilization limit efficient reprocessing of residues. Despite the fact that residue utilization has not been promoted on the basis of resources conservation or concern for environmental protection, economic incentives have favorably influenced the development of successful reutilization systems. Although advanced reprocessing techniques are not applied on a large scale for residue recovery, efficient and cost-effective technologies have been developed for whey utilization, yeast residues, starch residues, canning residues, edible oil wastes, and brewing residues. New applications are recommended for spent clays, straw pulping, composting of solid wastes, and recovery of sugar from cellulose residues. It is suggested that central treatment facilities would increase process efficiency, improve scale economy, respond better to future expansions, have greater seasonal flexibility, and facilitate recovery and reuse of materials. This type of centralized scheme would overcome two problems in Alexandria: (1) unavailability of land space, which prevents installation of waste treatment facilities at production sites; and (2) the inability of small-size agro-industries to implement sophisticated and expensive on-site residue recovery systems. (White-Reimer-PTT) W90-04862

CORRECTING WIDESPREAD CADMIUM CONTAMINATION.

Ohio State Univ., Columbus. Dept. of Agronomy. For primary bibliographic entry see Field 5G. W90-04879

AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE: A REVIEW.

R. D. Davis. Journal of the Institution of Water Engineers and Scientists IIWSDI, Vol. 3, No. 4, p 351-355, August 1989. 27 ref.

Descriptors: *Land disposal, *Sludge utilization, *Sludge disposal, *Reviews, Wastewater farming, Wastewater treatment, Wastewater disposal, Public nuisance, Water pollution, Pathogens, Soil contamination, United Kingdom.

Utilization on agricultural land is the principal outlet for sewage sludge in the United Kingdom, accounting for about 40% of the annual production. During the last 30 years current practice has developed to maximize the benefits to farmers while controlling potential problems of public nuisance, water pollution, pathogen transmission and

soil contamination. Until now this has been achieved by Government guidelines but, in the future, utilization of sewage sludge in agriculture will have a statutory basis following the implementation of an European Community Directive in June 1989. The comprehensive requirements of the legislation and the commitment of the water utilities to comply with them should help to dispel any lingering doubts about the acceptability of the practice occasionally raised by the sensational headlines which sludge can sometimes attract because of its origin, smell, and content of pathogens and contaminants. (Author's abstract) W90-04906

USE OF MIXING ZONE TO DERIVE A TOXICITY TEST CONSENT CONDITION.

Clyde River Purification Board, East Kilbride (Scotland). For primary bibliographic entry see Field 5G. W90-04907

USE OF REDOX POTENTIAL TO CONTROL FERRIC SULPHATE DOSING DURING PHOSPHATE REMOVAL.

Naia Aquatic Environmental Services, Norwich (England). For primary bibliographic entry see Field 5D. W90-04911

EFFECT OF SLUDGE DIGESTION ON METAL SEGREGATION DURING OCEAN DUMPING.

Delaware Univ., Newark. Coll. of Marine Studies.

R. J. Gibbs, and M. Angelidis. Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 10, p 503-508, October 1989. 2 fig, 2 tab, 18 ref.

NOAA Ocean Assessment Division grant NA-82-RAD009.

Descriptors: *Sludge disposal, *Sludge, *Heavy metals, *Ocean dumping, Water pollution sources, New York, Organic matter, Digested sludge, Flocculation, Sedimentation.

The variations in the metal chemical partitioning of the different settling velocity flocs, that are formed during the ocean dumping of sludges, were investigated in digested and undigested sludges originating from New York City Wastewater Treatment Plants. Major differences were found in the distribution of oxidizable and reducible metals. In the digested sludges, the maximum of the oxidizable metal concentrations were found in the larger flocs, while the smaller flocs contained higher concentrations of reducible metals. In the case of the undigested sludge, the large flocs had high concentrations of oxidizable metals, but the maximum concentrations of the organic-bound metals were found in the slowest settling micro-flocs. The undigested organic matter appears to be the reason for these differences. (Author's abstract) W90-04967

EC DIRECTIVE ON THE CONTROL OF DANGEROUS SUBSTANCES (7/464/EEC): ITS IMPACT ON THE UK WATER INDUSTRY.

Water Research Centre, Medmenham (England). For primary bibliographic entry see Field 5G. W90-05009

DRAINAGE OF LANDFILL COVERS AND BOTTOM LINERS: UNSTEADY CASE.

Kansas Univ., Lawrence. Dept. of Civil Engineering. For primary bibliographic entry see Field 5B. W90-05020

STEADY DRAINAGE OF LANDFILL COVERS AND BOTTOM LINERS.

Kansas Univ., Lawrence. Dept. of Civil Engineering. B. M. McEnroe. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 6, p 1114-1122, December 1989. 5 fig, 5 ref, append. University of Kansas General Research Allocation No. 3730-20-0038.

WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

Water Treatment and Quality Alteration—Group 5F

Descriptors: *Landfill covers, *Landfill linings, *Waste disposal, *Path of pollutants, *Landfills, *Drainage, Design criteria, Mathematical models, Hydraulic conductivity, Leakage, Boundaries, Slopes, Graphical methods, Subsurface drains.

To design a drainage system for a landfill cover or bottom liner properly, the engineer must be able to estimate the maximum saturated depth over the barrier for any proposed configuration. An analytical solution for steady drainage on a sloping impervious barrier with no flow across the upstream boundary is presented. Based on the Dupuit approximation, this solution defines all possible phreatic-surface profiles. The shape of the phreatic-surface profile depends on the values of three dimensionless parameters: the barrier slope, the ratio of the vertical inflow rate to the hydraulic conductivity of the drainage layer, and the ratio of the saturated depth at the downstream boundary to the maximum drainage distance. The latter parameter is significant only where liquid is ponded above the drain trench due to some malfunction. Several distinctly different types of profiles are possible. A graph is provided for determining the maximum saturated depth directly. (See also W90-05020) (Author's abstract)

W90-05021

SYNTHESIS OF RESEARCH RESULTS: APPLICABILITY AND FIELD VERIFICATION OF PREDICTIVE METHODOLOGIES FOR AQUATIC DREDGED MATERIAL DISPOSAL. Environmental Research Lab., Narragansett, RI. J. H. Gentile, G. G. Pesch, J. Lake, P. P. Yevich, and G. Zroogian. Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 175. Price codes: A04 in paper copy, A01 in microfiche. Technical Report D-88-5, September 1988. Final Report. 72p, 16 fig, 6 tab, 46 ref.

Descriptors: *Testing procedures, *Spoil disposal, *Waste disposal, *Dredging wastes, *Water pollution effects, Tissue analysis, Biological studies, Field tests, Bioaccumulation, Toxicity, Mussels, Polychaetes.

The Field Verification Program was designed to determine the applicability, reproducibility, and field verification of test methods for the evaluation of disposal of dredged material at aquatic, upland, and wetland sites. There were three objectives in this program: (1) to demonstrate the applicability of existing test methods to detect and measure effects of dredged material and to determine the degree of variability and reproducibility inherent in the testing procedures; (2) to field verify the laboratory responses by comparing the exposure-response relationships between the laboratory and field; and (3) to determine the degree of correlation between contaminated tissue residues and biological responses resulting from laboratory and field exposure to dredged residues and biological responses resulting from laboratory and field exposure to dredged material. These objectives were examined for the following biological responses: bioaccumulation, scope for growth, bioenergetics, adenylate energy charge, sister chromatid exchange, histopathology, survival, growth, reproduction, intrinsic rates of population growth, recolonization, and community structure. The following recommendations are made regarding the application of the test methods in this study for dredged material evaluation: (1) measures of survival, growth, reproduction, population, scope for growth, and contaminant bioaccumulation are recommended in the predisposal evaluation of dredged material; (2) while a genotoxic test method is desirable in the predisposal evaluation, sister chromatid exchange is not recommended pending further development of the test method; (3) acceptable methods for post-disposal field assessments include scope for growth, growth, and bioaccumulation measured in *Mytilus edulis* and bioenergetics and bioaccumulation in *Nephtys incisa*; and (4) benthic community assessment methods are recommended for rapid reconnaissance applications and species classification and enumeration for definitive assessments. (Lantz-PTT)

W90-05145

APPLICATIONS OF EXPERT SYSTEMS IN ENVIRONMENTAL ENGINEERING.

Environmental Protection Agency, Cincinnati, OH.

L. A. Rossman.

IN: Dynamic Modeling and Expert Systems in Wastewater Engineering. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 241-259, 3 fig, 3 tab, 16 ref.

Descriptors: *Expert systems, *Computer programs, *Environmental engineering, *Waste disposal, Model studies, Hazard assessment, Synthetic liners, Landfills, Environmental protection.

Expert systems are a promising computer-based approach to helping environmental engineers solve difficult problems. A number of such systems have been developed to date in the areas of hazard assessment, modeling support, process failure diagnosis and regulatory support. The US EPA has several programs underway to introduce this technology into its operations. The most ambitious of these is the work being undertaken by EPA's Hazardous Waste Engineering Research Laboratory. They are developing five systems that support the review of applications for operating permits for RCRA (Resource Conservation and Recovery Act) hazardous waste facilities and selection of remedial action alternatives at Superfund cleanup sites. The most highly developed of these is FLEX (Flexible Liner Evaluation Expert), a program that evaluates the chemical resistance of synthetic liners exposed to wastes contained in landfills and impoundments. FLEX contains 347 rules encoded in the Prolog language along with special data management routines written in C. Work on FLEX and other systems has identified a number of issues important to successful implementation of expert systems within an organization such as the EPA. More successful applications of the technology to real engineering problems are needed to maintain the momentum achieved to date. (See also W90-05149) (Lantz-PTT)

W90-05157

PROPOSED TECHNICAL SLUDGE REGULATION UPDATE.

Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.

J. M. Walker.

Biocycle BCYCDK, Vol. 30, No. 11, p 46-48, November 1989.

Descriptors: *Sludge disposal, *Regulations, *Sludge utilization, Sludge conditioning, Wastewater management, Legal aspects.

Comments and issues brought up during the peer review of the U.S. Environmental Protection Agency's (EPA) proposed comprehensive technical sludge regulations (40 CFR Part 503) are discussed. The proposed rules were criticized as being overly stringent and therefore discouraging the beneficial use of sludge by the greatest number of commenters. Although incinerator operators disagreed with the definition of the most exposed individual (MEI) used in the proposal, they felt that they could meet whatever the ultimate emission control requirements might be. The U.S. Forest Service expressed reservations about sludge utilization on forest land, partly because of a lack of staff to monitor the practice. A presentation of analyses and proposed responses to concerns brought up by the peer review groups is expected sometime between November 1989 and January 1990. Although the Association of Metropolitan Sewerage Agencies (AMSA) and members of the first peer review group urged a reproposal and utilization of regulatory negotiations, probably neither process will take place because of a lawsuit filed by the Natural Resources Defense Council (NRDC) for the EPA's delay in issuing regulations to control sewage sludge management practices. There are no plans to repropose the regulations. (Male-PTT)

W90-05348

COMBINED RO/FREEZING SYSTEM TO REDUCE INLAND REJECTED BRINE. King Abdulaziz Univ., Jeddah (Saudi Arabia).

Dept. of Mechanical Engineering.

For primary bibliographic entry see Field 3A. W90-05440

1988 ANNUAL WATER QUALITY DATA REPORT FOR THE WASTE ISOLATION PILOT PLANT.

IT Corp., Carlsbad, NM.

W. S. Randall, M. E. Crawley, and M. L. Lyon. Available from the National Technical Information Service, Springfield, VA 22161, as DE88-015581. Price codes: A22 in paper copy, A01 in microfiche. Report No. DOE/WIPP-88-006, March 1988. 484p, 99 fig, 99 tab, 20 ref. DOE Contract DE-AC04-86AL31950.

Descriptors: *Waste disposal, *Radioactive waste disposal, *Water quality, *New Mexico, Data collections, Waste Isolation Pilot Plant, Water chemistry, Wells, Trace metals.

The Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico, is a Department of Energy research and development facility designed to demonstrate the safe disposal of transuranic radioactive waste resulting from the nation's defense programs. The Water Quality Sampling Program (WQSP) supports four major programs for the WIPP: Site Characterization, Performance Assessment, the Radiological Baseline Program, and the Ecological Monitoring Program. Results from 24 WQSP wells sampled from January 1987 through November 1987 are presented in this report. Water quality data from two water-bearing zones have been collected. These zones are the Culebra and Magenta Dolomite Members of the Rustler Formation. Analytical results from the sampling program include field chemistry data, general water quality parameters, trace metals, EPA priority pollutants, dissolved gases and selected redox couples. In addition to the WQSP wells mentioned above, 9 private wells were sampled for primary and secondary drinking water parameters and radionuclides. Six wells were analyzed for trace metal concentrations and priority pollutants as well as general water quality parameters and radionuclides. The water samples from the private wells came from three water bearing zones, the Santa Rosa Sandstone of the Dockum Group, the Dewey Lake Red Beds Formation and the Culebra Dolomite Member of the Rustler Formation. In some instances where no reliable well completion logs are available it was not clear which actual water bearing zone the well was completed in. It is hoped that with the continuing search for records and analysis of the water samples the source of the water may be determined. (Lantz-PTT)

W90-05598

5F. Water Treatment and Quality Alteration

PLASTIC PIPE: A CHANCE FOR REVIVAL. Simpson Gumpertz and Heger, Inc., Arlington, MA.

For primary bibliographic entry see Field 8G. W90-04575

WATER TREATMENT NEEDS ACCELERATE.

Hazen and Sawyer, New York.

W. B. Sinnott.

Water Engineering and Management WENMD2, Vol. 136, No. 6, p 32-35, June 1989.

Descriptors: *Water treatment, *Drinking water, *Potable water, *Water quality control, *Administrative regulations, Water law, Water quality, Legislation, Ozonation, Filtration, Disinfection, Raw water.

The contribution of the 1986 Amendments to the Safe Drinking Water Act (SDWA) on the significant acceleration in activity in the planning and development of new and upgraded water treatment facilities are reviewed. The Amendments to the SDWA and proposed EPA regulations to implement the amendments encompass far-reaching and complex requirements covering maximum con-

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5F—Water Treatment and Quality Alteration

taminant levels, degree of treatment, protection of groundwater sources, deadlines for promulgation of requirements, and procedures for the states obtaining 'primacy' in enforcement of the proposed regulations. The principal effects of the Amendments begin with the proposed surface water treatment requirements (SWTR). Surface waters will have to be filtered unless the 'primacy' agent, usually the state, grants an exemption. An exemption can be granted under certain conditions where raw and distributed water quality meets certain requirements including limits on the concentration of fecal and total coliform before disinfection, raw water turbidity less than 5 NTU, and disinfection methods capable of achieving almost 100% inactivation of *Giardia lamblia* and enteric viruses. The proposed SWTR includes performance and monitoring requirements for existing conventional, direct, slow-sand and diatomaceous-earth filtration systems. Ozonation is likely to be used with increasing frequency where raw waters contain naturally occurring organic chemicals such as humic and fulvic acids that react with chlorine to form total trihalomethanes. For groundwater treatment, the Amendments require that the states establish wellhead protection areas surrounding public water-supply wells to prevent further contamination of existing aquifers. (Friedmann-PTT) W90-04576

DOSE-RESPONSE RELATION BETWEEN ARSENIC CONCENTRATION IN WELL WATER AND MORTALITY FROM CANCERS AND VASCULAR DISEASE.
Academia Sinica, Taipei (Taiwan). Inst. of Biomedical Sciences.
For primary bibliographic entry see Field 5C. W90-04634

BACKCOUNTRY WATER TREATMENT TO PREVENT GIARDIASIS.
Washington Univ., Seattle. Dept. of Environmental Health.
J. E. Ongerth, R. L. Johnson, S. C. Macdonald, F. Frost, and H. H. Stibbs.
American Journal of Public Health AJHEAA, Vol. 79, No. 12, p 1633-1637, December 1989. 3 fig, 10 ref, 3 append.

Descriptors: *Parasites, *Giardia, *Water treatment, *Chemical treatment, *Disinfection, *Filtration, Iodine, Chlorine, Camping.

A study was conducted to provide current information on the effectiveness of water treatment chemicals and filters for control of *Giardia* cysts in areas where treated water is not available. Four filters and seven chemical treatments were evaluated for both clear and turbid water at 10°C. Three contact disinfection devices were also tested for cyst inactivation. Filters were tested with 1-liter volumes of water seeded with 30,000 cysts of *G. lamblia* produced in gerbils inoculated with in vitro cultured trophozoites; the entire volume of filtrate was examined for cyst passage. Chemical treatments were evaluated at concentrations specified by the manufacturer and for contact times that might be expected of hikers (30 minutes) and campers (8 hours, i.e., overnight). Two of the four filter devices tested were 100% effective for *Giardia* cyst removal. Of the other two filters, one was 90% effective and the other considerably less effective. Among the 7 disinfection treatments, the iodine-based chemicals were all significantly more effective than the chlorine-based chemicals. None of the chemical treatments achieved 99.9% cyst inactivation with only 30-minute contact. After an 8-hour contact each of the iodine but none of the chlorine preparations achieved at least 99.9% cyst inactivation. None of the contact disinfection devices provided appreciable cyst inactivation. Heating water to at least 70°C for 10 minutes was an acceptable alternative treatment. (Author's abstract) W90-04635

MEMBRANE FILTRATION DIFFERENTIATION OF E. COLI FROM COLIFORMS IN THE EXAMINATION OF WATER.
Public Health Lab., Haifa (Israel).

For primary bibliographic entry see Field 5A. W90-04646

SURVEY OF BARIUM IN ITALIAN DRINKING WATER SUPPLIES.
Florence Univ. (Italy). Inst. of Hygiene.
For primary bibliographic entry see Field 5A. W90-04676

AQUEOUS CHLORINATION OF RESORCINOL.
Point Loma Nazarene Coll., San Diego, CA. Dept. of Chemistry.
V. L. Heasley, M. D. Burns, N. A. Kemalyan, T. C. McKee, and H. Schroeter.
Environmental Toxicology and Chemistry ETODCK, Vol. 8, No. 12, p 1159-1163, 1989. 3 fig, 1 tab, 8 ref.

Descriptors: *Water pollution sources, *Chloroform, *Chlorination, *Resorcinol, *Water treatment, *Phosphates, Chlorinated hydrocarbons, Drinking water.

Chloroform in drinking water results primarily from the reaction of chlorine with the 1,3-dihydroxybenzene compounds of humic materials such as resorcinol. The mechanisms of the early stages of the aqueous chlorination of resorcinol were studied with and without phosphate buffer. The following intermediates were detected in moderate to high yield at different pH values and varying percentages of chlorination: 2-chloro-, 4-chloro-, 2,4-dichloro-, 4,6-dichloro-, and 2,4,6-trichlororesorcinol. Only trace amounts of the intermediates were detected when the chlorination was conducted in the presence of phosphate buffer. This result has significant implications since resorcinol in phosphate buffer has been used as a model compound in several recent studies on the formation of chlorinated hydrocarbons during chlorination of drinking water. Relative rates of chlorination were determined for resorcinol and several of the chlorinated resorcinols. Resorcinol was found to chlorinate only three times faster than 2,4,6-trichlororesorcinol. The structure 2,4,6-trichlororesorcinol was established as a monohydrate even after sublimation. A tetrachloro or pentachloro intermediate was not detected, suggesting that the ring-opening step of such an intermediate must be rapid. (Author's abstract) W90-04693

EFFICACY AND MECHANISM OF REMOVAL OF ORGANIC SUBSTANCES FROM WATER BY OZONE AND ACTIVATED CARBON.
Jilin Architectural and Civil Engineering Inst., Changchun (China). Dept. of Urban Engineering.
For primary bibliographic entry see Field 5D. W90-04758

PREDATION AND DEODORIZATION OF MUSTY ODOR-PRODUCING FILAMENTOUS ALGAE BY THE PROTOZOA TRITHIGMOTOMA CUCULLULUS.
National Inst. for Environmental Studies, Tsukuba (Japan).
R. Sudo, Y. Inamori, Y. Kuniyasu, and T. Ouchiya.

Water Science and Technology WSTED4, Vol. 21, No. 12, p 1743-1746, 1989. 1 fig, 2 tab, 6 ref.

Descriptors: *Biofilters, *Water treatment, *Odor control, *Algae, *Protozoa, *Odor-producing algae, Predation, Filamentous algae, Biological treatment.

The protozoa *Trithigmotoma cucullulus* was fed several types of algae: *Phormidium tenue* and *Oscillatoria agardhii* (filamentous), *Microcystis aeruginosa*, *Scenedesmus acuminatus* var. *tetrademoides* and *Chlorella vulgaris* (non-filamentous). The protozoa could not ingest non-filamentous algae. However, *T. cucullulus* was very effective in reducing the odor of raw lake water (about 50%) by predation on the filamentous alga *P. tenue*. Turbidity, total organic carbon, and dissolved organic carbon were markedly lower in the system with *T. cucullulus* as compared to the

control. The predation speed of the protozoa was about 10 to 30 microm/s. Optimum living conditions for the organisms included a temperature of 20 to 25°C, addition of sludge extract, and low salt concentration. (Cassar-PTT) W90-04760

OUTFLOWS OF ORGANIC HALIDE PRECURSORS FROM FOREST REGIONS.
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
S. Saito, K. Hattori, and T. Okumura.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1877-1880, 1989. 4 fig, 3 ref.

Descriptors: *Water treatment, *Chlorination, *Halides, *Water pollution sources, *Forests, *Organic compounds, *Trihalomethanes, Yodo River Basin, Japan, Rainfall, Precipitation, Runoff, Forest soils, Soil chemistry, Throughfall.

Outflows of organic halide precursors from a forest region in the Yodo River basin, Japan, were studied and equations developed for pollution loads derived from precipitation, throughfall, surface soil layer, and deep soil layer. Loads in precipitation were constant, regardless of rainfall amount. Loads from the surface and deep soil layers were constant, regardless of rainfall intensity, preceding dry days, and rainfall duration. Rainfall data from the Kiryu Test Forest (2155 mm annual rainfall, 58 events) were used in the equations to calculate the annual outflow of organic halide precursors, 0.10 g/sq m for precipitation, 3.5 g/sq m for throughfall, 4.7 g/sq m for the surface soil layer, and 0.11 g/sq m for the deep soil layer. (Cassar-PTT) W90-04794

RESERVOIR SEDIMENTS AS POTENTIAL SOURCE OF HEAVY METALS IN DRINKING WATER (SARDINIA, ITALY).
Cagliari Univ. (Italy). Ist. di Igiene e Medicina Preventiva.
For primary bibliographic entry see Field 5B. W90-04797

MUTAGENIC ACTIVITY OF ORGANIC CONCENTRATES FROM MUNICIPAL RIVER WATER AND SEWAGE EFFLUENT AFTER CHLORINATION OR OZONATION.
Setsunan Univ., Neyagawa (Japan). Faculty of Pharmaceutical Sciences.
For primary bibliographic entry see Field 5C. W90-04798

DETERMINATION OF VOLATILIZATION COEFFICIENTS OF TRIHALOMETHANES FROM WATERS.
Hosei Univ., Tokyo (Japan). Chemical Lab.
S. Okouchi, and H. Saegusa.
Water Science and Technology WSTED4, Vol. 21, No. 12, p 1907-1912, 1989. 7 fig, 1 tab, 13 ref.

Descriptors: *Fate of pollutants, *Chlorinated hydrocarbons, *Water treatment, *Trihalomethanes, *Drinking water, Volatilization, Aeration, Mathematical analysis.

The volatilization rates of trihalomethanes (CHCl_3 , CHBrCl_2 , CHBr_2Cl , and CHBr_3) were measured under various mixing conditions concurrently with those of oxygen and water. The volatilization coefficients of trihalomethanes were determined from their volatilization rates as the ratios of mass transfer coefficients in respective liquid and gas phases between trihalomethanes and oxygen or water by new and conventional methods. The new method was indicated to be effective for the determination of the volatilization coefficient of a chemical with dimensionless Henry's constant lower than about 0.1. The volatilization coefficients of trihalomethanes obtained can be applied for estimating their volatilization rates under conditions in which either the water- or gas-film resistances dominate or both film resistances are significant. (Author's abstract) W90-04801

Water Treatment and Quality Alteration—Group 5F

COMPLEXING OF COPPER IN DRINKING WATER SAMPLES TO ENHANCE RECOVERY OF AEROMONAS AND OTHER BACTERIA. Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). J. F. M. Versteegh, A. H. Havelaar, A. C. Hoekstra, and A. Visser. *Journal of Applied Bacteriology* JABAA4, Vol. 67, No. 5, p 561-566, November 1989. 1 fig, 3 tab, 12 ref.

Descriptors: *Sampling, *Water analysis, *Metal complexes, *Water treatment, *Pathogenic bacteria, *Drinking water, *Copper, *Bacterial analysis, *Aeromonas, *Coliforms, *Streptococcus, Chelating agents, Chemical treatment, The Netherlands.

In May 1984, a sudden increase of non-lactose-fermenting bacteria was noticed during routine examinations for coliform bacteria in the drinking water produced by the Dune Water Works of the Hague. This incident, and the suggested role of drinking-water aeromonads in childhood gastroenteritis, led to intensive monitoring of water supplies in the Hague and elsewhere for aeromonads. During these investigations it was noted that counts of Aeromonas in samples of water leaving the water works were always lower than the weighed mean of counts in the individual slow sand filters producing the finished water. It was felt that this reduction in colony-forming units might be related to toxic effects of copper dissolving from the long sampling pipe (approximately 35 m) used for collecting finished water samples. A more detailed study of the toxicity of copper towards aeromonads and other bacteria in drinking water samples was therefore undertaken and the usefulness of neutralization by addition of EDTA was evaluated. (Author's abstract) W90-04811

SPECIFICITY OF THE DPD AND AMPEROMETRIC TITRATION METHODS FOR FREE AVAILABLE CHLORINE: A REVIEW.

State Univ. of New York at Buffalo. Dept. of Civil Engineering. J. N. Jensen, and J. D. Johnson. *Journal of the American Water Works Association* JAWWA5, Vol. 81, No. 12, p 59-64, December 1989. 1 fig, 8 tab, 70 ref.

Descriptors: *Literature review, *Laboratory methods, *Water treatment, *Wastewater treatment, *Chlorination, *Disinfection, *Chlorine, *Chemical analysis, Amperometric titration, Colorimetry, Chloramines, Chemical interference.

Chlorine reacts with natural water and wastewater constituents to produce a variety of compounds with a variety of disinfection abilities. Free available chlorine (FAC) is a strong disinfectant. The objective of this article is to review the literature concerning interferences from monochloramine and organic chloramines in the measurement of FAC. Both the DPD (N,N-diethyl-p-phenylenediamine) and amperometric titration methods for measuring free available chlorine are subject to interference from monochloramine and organic chloramines. The measured FAC concentration in the presence of chloramines is often significantly larger than the true FAC residual. Interference in the DPD method can be reduced by rapid titrations. Interference in the amperometric titration method can be minimized by maintaining a 200-mV positive potential on the platinum electrode. (Author's abstract) W90-04812

PREDICTING THE MULTICOMPONENT REMOVAL OF SURROGATE COMPOUNDS BY A FIXED-BED ADSORBER.

Amway Corp., Ada, MI. Research and Development Div. R. W. Kuennen, K. Van Dyke, J. C. Crittenden, and D. W. Hand. *Journal of the American Water Works Association* JAWWA5, Vol. 81, No. 12, p 46-58, December 1989. 19 fig, 6 tab, 27 ref.

Descriptors: *Water treatment, *Organic pollutants, *Adsorption, *Activated carbon, Fixed-bed

adsorber, Drinking water, Organic compounds, Mass transfer models, Prediction.

The use of granular activated carbon (GAC) in fixed beds has been shown to be a cost-effective and viable technique for removing trace organic pollutants in water provided that the fixed-bed adsorber (FBA) is properly designed. The design of an FBA requires a significant database of information. This varies from characterizing the adsorption capacity of GAC for the organic pollutants to selecting the process flow configuration and proper empty bed contact time (EBCT) for a given GAC particle size. Recently, substantial progress has been made with the development of pore diffusion and surface diffusion mass transfer models, and in some instances, they may be used to predict multicomponent competitive interactions at the surface of GAC and to select GAC operational variables. Pore and surface diffusion mass transfer models were used to predict the breakthrough profiles of a 14-component mixture eluting from a point-of-use fixed-bed adsorber. The 14 compounds were surrogates, representing a variety of organics from different classes and groups commonly found in contaminated drinking water. Adsorption isotherms were done for all 14 compounds. Polanyi adsorption potential theory was used to correlate single-solute isotherm parameters at 21°C and predict isotherm parameters at 6°C. Ideal adsorbed solution theory was used in the mass transfer models to correlate the single-solute predicted isotherms at 6°C and calculate competitive interactions at the surface of the activated carbon. (Author's abstract) W90-04813

ORGANICS ISOLATION FROM FRESH AND DRINKING WATERS BY MACROPOROUS ANION-EXCHANGE RESINS.

Politechnika Warszawska (Poland). Faculty of Sanitary and Hydraulic Engineering. For primary bibliographic entry see Field 5A. W90-04848

OUTBREAK OF MYCOBACTERIUM TERRAE IN CLINICAL SPECIMENS ASSOCIATED WITH A HOSPITAL POTABLE WATER SUPPLY.

University Hospital, Ann Arbor, MI. Div. of Infectious Diseases. W. W. Lockwood, C. Friedman, N. Bus, C. Pierson, and R. Gaynes. *American Review of Respiratory Disease* ARDSBL, Vol. 140, No. 6, p 1616-1617, December 1989. 1 fig, 2 tab, 20 ref.

Descriptors: *Drinking water, *Potable water, *Pathogenic bacteria, Water conveyance, Contamination, Mycobacterium, Hospitals.

At the Dept. of Infection Control Services at the University of Michigan Hospitals, an increase in the number of patient specimens yielding *Mycobacterium terrae* in 1986 was investigated. Isolation of *M. terrae* was associated with specimens obtained from inpatients at a new hospital, but not with specimens referred from other hospitals, (37+/-144 inpatient specimens versus 2+/-26 referred specimens, $p < 0.05$). By October 31, 1987, 163 positive specimens from 131 patients were identified. All *M. terrae* were isolated from specimens obtained from nonsterile sites, i.e., respiratory, gastrointestinal, or urine. No clinical disease related to *M. terrae* occurred. Review of procedures and cultures of solutions used in the Microbiology Laboratory suggested the source of *M. terrae* was not in the Microbiology Laboratory. An analysis of case location showed an association with hospital tier ($p < 0.05$), a pattern matching the design of the potable water system of the hospital. *M. terrae* was cultured from multiple outlets of this system. There appeared to be multiple modes of transmission of *M. terrae* from this reservoir. Control measures included avoidance of water sources during specimen collection and hyperchlorination of the potable water system. These measures appeared to result in the disappearance of *M. terrae* from subsequent clinical specimens. It is believed that this is the first report defining the epidemiologic aspects of *M. terrae* contaminating specimens. (Author's abstract)

W90-04859

DESIGNING VENICE'S WASTEWATER SYSTEM.

Venice Public Drainage Dept., Padua (Italy). For primary bibliographic entry see Field 5D. W90-04880

MORE AND BETTER WATER FOR THIRSTY SAO PAULO, BRAZIL.

Montgomery (James M.), Inc., Pasadena, CA. S. Kawamura, L. A. M. Pacheco, P. E. A. de Souza, and M. Omori. *Journal of the American Water Works Association* JAWWA5, Vol. 81, No. 10, p 32-38, October 1989. 5 fig, 6 tab.

Descriptors: *Water Conveyance, *Water Treatment, *Water treatment facilities, *Brazil, Design standards.

One of the fastest growing industrial cities in the world, Sao Paulo, Brazil, is located in a region with scarce water resources. Supplying adequate water to the greater Sao Paulo metropolitan area is a monumental task. At the present time, 1,070 mgd (47 cubic meters per s) of water is supplied to 15 million people in the area, but it is not enough. An additional 450 mgd (20 cubic meters per s) will be needed by the turn of the century. To meet this challenge, Companhia de Saneamento Basico do Estado de Sao Paulo (SABESP) has developed a new water supply system, the Alto Tiete system, to cover the eastern part of the metropolitan area, together with a 340-mgd (15 cubic meter per s) capacity state-of-the-art water treatment plant, which is now under construction. A special feature of this plant is great operational flexibility in regard to the treatment process mode and chemical application points. Another feature is a provision for future addition of a preozonation process and adaptation of the coarse deep monomedium filter, which not only applies an 8-gpm/sq ft (20-m/h) filtration rate (with a filter run length similar to that of a dual-media filter with a 12.5-m/h rate) but can also be converted to a granular activated carbon adsorption bed. (Male-PTT) W90-04897

WATERTECH USA: A PROGRAM FOR HELPING DEVELOPING NATIONS.

Kalbermatten Associates, Inc., Washington, DC. J. Kalbermatten. *Journal of the American Water Works Association* JAWWA5, Vol. 81, No. 10, p 39-44, October 1989. 2 tab.

Descriptors: *Drinking water, *Water treatment, *Developing countries, Water supply, Sanitation, Management planning.

A plan to organize an American Water Works Association (AWWA)-sponsored program that would provide technical assistance and training to help less developed countries improve their drinking water supply and sanitation services is proposed. This program involves coordinating the efforts of national and world-wide organizations in regard to funding and project development. Initial activities should be undertaken under the direction of the AWWA International Affairs Committee, the primary focus being on mobilizing support and raising funds sufficient to hire a consultant or interim executive director to assume the following responsibilities: (1) preparation of proposals for foundation seed money; (2) preparation of a detailed activities plan; (3) development of a roster of retired utility professionals, consultants, and manufacturers' personnel who would volunteer for assignments; and (4) identification of other activities that could be implemented quickly and with minimal funding. (Male-PTT) W90-04898

EXTERNAL CORROSION IN DISTRIBUTION SYSTEMS.

Weston (Roy F.), Inc., West Chester, PA. D. K. O'Day.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5F—Water Treatment and Quality Alteration

Journal of the American Water Works Association JAWWA, Vol. 81, No. 10, p 45-52, October 1989, 6 fig, 5 tab, 21 ref.

Descriptors: *Water distribution, *Water treatment, *Corrosion, Water mains, Structural behavior.

Many utilities do not appreciate the fact that routine breaks of metal water mains often result from deterioration caused by gradual external corrosion. The basic terms and conditions of galvanic and electrolytic corrosion are outlined. Case studies illustrate causes of external corrosion of underground metal mains and describe methods to control external corrosion. The role of soil in external corrosion is discussed. An evaluation of the effects of soil corrosivity involves the role of soil characteristics: sulfate-reducing bacteria; and soil chemistry such as pH, redox potential, sulfides, and moisture. Critical research needs identified include prolonging existing main life, identifying and controlling electrolytic corrosion problems, and evaluating the economics of corrosion control for new mains. (Male-PTT) W90-04899

MINIMIZING THM FORMATION DURING CONTROL OF THE ASIATIC CLAM: A COMPARISON OF BIOCIDES.

Houston Univ., TX. Dept. of Biology. G. N. Cameron, J. M. Symons, S. R. Spencer, and J. Y. Ma. Journal of the American Water Works Association JAWWA, Vol. 81, No. 10, p 53-62, October 1989, 6 fig, 5 tab, 30 ref.

Descriptors: *Water treatment, *Chlorination, *Trihalomethanes, *Clams, Organic compounds, Bicides, Corbicula, Water conveyance.

In many parts of the United States, water utilities with highly organic source waters and long source water transmission lines are troubled by *Corbicula fluminea*, the Asiatic clam. The traditional method of control, free chlorination, often can no longer be used because of the formation of excessive amounts of trihalomethanes (THMs). The effectiveness of six biocides (potassium permanganate, copper, chloramine, free chlorine, bromamine, and chlorine dioxide) for controlling the juvenile Asiatic clam was compared. Because hydraulic detention time in the distribution pipeline was short (15-18 h) and animals could exit the system and hence minimize exposure to biocides, biocide effectiveness was monitored in an arbitrarily-selected 24-h period. The study showed that, in a 24-h period, free chlorine (which also produced THMs), copper, and potassium permanganate were ineffective; bromamines, although somewhat effective, produced THMs; and chlorine dioxide and chloramines were effective. From a cost and ease-of-handling point of view, chloramine was the biocide of choice. (See also W90-04901) (Male-PTT) W90-04900

EFFECT OF TEMPERATURE AND PH ON THE TOXICITY OF MONOCHLORAMINE TO THE ASIATIC CLAM.

Houston Univ., TX. Dept. of Biology. G. N. Cameron, J. M. Symons, D. Bushek, and R. Kulkarni. Journal of the American Water Works Association JAWWA, Vol. 81, No. 10, p 62-71, October 1989, 5 fig, 6 tab, 15 ref. Financial assistance for this research provided by the CWA and the University of Houston Computing Center.

Descriptors: *Trihalomethanes, *Water conveyance, *Clams, Methane, Organic compounds, Bicides, Water temperature, Hydrogen ion concentration, Corbicula.

The Asiatic clam (*Corbicula fluminea*) has become a pest to many users of freshwater transmission systems. Monochloramine has been suggested as a biocide because it is effective and the formation of trihalomethanes is low. Flow-through aquariums, a laboratory incubator, and a pilot-scale pipeline were used to show that monochloramine concentrations between 1 and 10 milligrams per liter

effectively killed juvenile clams over a wide range of water temperatures, with mortality increasing significantly with temperature. The reduction in clam mortality as water temperature decreases can be overcome by corresponding increases in biocide concentration. An equation is provided that predicts the kill that would be achieved at a given biocide residual and water temperature. The pH did not affect the efficacy of the biocide. (See also W90-04900) (Author's abstract) W90-04901

EC DIRECTIVE ON DRINKING WATER (EEC 80/778).

Severn-Trent Water Authority (England). R. A. Breach. Journal of the Institution of Water Engineers and Scientists JIWSI, Vol. 3, No. 4, p 323-327, August 1989.

Descriptors: *Drinking water, *United Kingdom, *Water treatment, *Europe, Legislation, Monitoring, Standards, Public health.

The European Drinking Water Directive has had more major implications for the United Kingdom than were anticipated. Although the inadequacies of the Directive are becoming increasingly recognized, there is no doubt that it has had a major impact on the UK water industry, much of which will be beneficial in the long term. However, it has provided a significant challenge to water suppliers on technical and environmental issues, as well as in new areas such as publicity and customer awareness. There are four main differences between UK and other European water supply infrastructure: (1) Seventy-five percent of the UK water supply is of surface origin and receives conventional treatment compared with 33% for the rest of Europe; (2) UK systems are less extensive or integrated; (3) the UK has an effective and open monitoring system for water quality due to the small number of water authorities; and (4) the UK has a small but effective group of environmental pressure groups. The impact of the Directive on the UK will be in the areas of: (1) clarity of standards; (2) publicity; and (3) improved service. The principle of having sensible, common European standards for drinking water quality will ultimately be beneficial despite the acknowledged number of technical difficulties. (Author's abstract) W90-04902

ECOLOGY AND SURVIVAL OF LEGIONELLA PNEUMOPHILA.

Thames Water Authority, London (England). For primary bibliographic entry see Field 5B. W90-04905

WELLFIELD DEVELOPMENT FOR URBAN WATER SUPPLIES IN PDR YEMEN.

J. C. Davey. Journal of the Institution of Water Engineers and Scientists JIWSI, Vol. 3, No. 4, p 413-422, August 1989, 4 fig, 1 tab, 9 ref.

Descriptors: *Water supply, *Water supply development, *Groundwater potential, *Yemen, Urban areas, Geohydrology, Potable water, Wells.

Internationally-funded groundwater projects have recently been completed for the main urban areas of People's Democratic Republic of Yemen: (1) Improvements at Bir Nasir and the commissioning of the Upper Abyan well field have led to enhanced supplies throughout Greater Aden; (2) after years of shortages Al Mukalla can look forward to adequate water supplies when the An Nagah wellfield is commissioned and remedial works to optimize existing investment at Wadi Buwaysh are completed; and (3) further developments at Seiyun and farther east will help to spread the benefits of a new water supply system throughout the Hadramaut valley. The necessary resources to secure potable supplies into the next century have been proved in Cretaceous sandstone, Eocene limestone and Quaternary alluvial aquifers, and their investigation has highlighted the importance of comprehensive hydrogeological studies prior to permanent works design and construction. The

projects discussed will improve the quantity, quality and accessibility of potable water to nearly one third of the country's population. (Author's abstract) W90-04913

EFFICACY OF COPPER AND SILVER IONS AND REDUCED LEVELS OF FREE CHLORINE IN INACTIVATION OF LEGIONELLA PNEUMOPHILA.

Arizona Univ., Tucson. Dept. of Microbiology and Immunology. L. K. Landeen, M. T. Yahya, and C. P. Gerba. Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3045-3050, December 1989, 4 fig, 6 tab, 37 ref.

Descriptors: *Water treatment, *Chlorination, *Copper, *Silver, *Legionella, *Disinfection, Bactericides, Water conditioning, Chemical treatment.

Water disinfection systems utilizing electrolytically generated copper and silver ions (200 and 20, 400 and 40, or 800 and 80 microgram/L) and low levels of free chlorine (0.1 to 0.4 mg/L) were evaluated at room (21 to 23 C) and elevated (39 to 40 C) temperatures in filtered well water (pH 7.3) for their efficacy in inactivating *Legionella pneumophila*. At room temperature, a contact time of at least 24 hours was necessary for copper and silver (400 and 40 microgram/L) to achieve a 3-log₁₀ reduction in bacterial numbers. As the copper and silver concentration increased to 800 and 80 microgram/L, the inactivation rate significantly increased from .00287 to .00750 (log reduction per minute). In water systems with and without copper and silver (400 and 40 microgram/L), the inactivation rates significantly increased as the free chlorine concentration increased from 0.1 mg/L (inactivation rate = 0.397 log reduction per min) to 0.4 mg/L (inactivation rate = 1.047 log reduction per min). Compared to room temperature, no significant differences were observed when 0.2 mg of free chlorine per liter with and without 400 and 40 microgram of copper and silver per liter was tested at room temperature. All disinfection systems, regardless of temperature or free chlorine concentration, showed increase inactivation rates when 400 and 40 microgram of copper and silver per liter was added; however, this trend was significant only at 0.4 mg of free chlorine per liter. (Author's abstract) W90-04931

COMPARISON OF MEMBRANE FILTRATION AND AUTOANALYSIS COLILERT PRESENCE-ABSENCE TECHNIQUES FOR ANALYSIS OF TOTAL COLIFORMS AND ESCHERICHIA COLI IN DRINKING WATER SAMPLES.

Glenmore Waterworks Lab., Calgary (Alberta). For primary bibliographic entry see Field 5A. W90-04933

ENUMERATION OF ENTEROBACTER CLOACAE AFTER CHLORAMINE EXPOSURE.

Montana State Univ., Bozeman. Dept. of Microbiology. S. K. Watters, B. H. Pyle, M. W. LeChevallier, and G. A. McFeters. Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 12, p 3226-3228, December 1989, 2 fig, 1 tab, 17 ref. American Water Works Association Research Foundation grant 309-87.

Descriptors: *Bacterial analysis, *Enterobacter, *Coliforms, *Disinfection, *Chlorination, Chloramine, Enterobacter, Culturing techniques, Water treatment.

Growth of *Enterobacter cloacae* on various media was compared after disinfection. This was done to examine the effects of monochloramine and chlorine on the enumeration of coliforms. The media used were TLY (nonselective; 5.5% tryptic soy broth, 0.3% yeast extract, 1.0% lactose, and 1.5% Bacto-Agar), m-T7 (selective; developed to recover injured coliforms), m-Endo (selective; contains sodium sulfite), TLYS (TLY with sodium sulfite),

WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

Water Treatment and Quality Alteration—Group 5F

and m-T7S (m-T7 with sodium sulfite). Sodium sulfite in any medium improved the recovery of chloramine-treated *E. cloacae*. However, sodium sulfite in TLYS and m-T7S did not significantly improve the detection of chlorine-treated *E. cloacae*, and m-Endo was the least effective medium for recovering chlorinated bacteria. Differences in recovery of chlorine-treated and chloramine-treated *E. cloacae* are consistent with mechanistic differences between the disinfectants. (Author's abstract)
W90-04937

RELATIONSHIPS AMONG TRIHALOMETHANE FORMATION POTENTIAL, ORGANIC CARBON AND LAKE ENRICHMENT.
Pittsburg State Univ., KS. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-04942

COMPARISON OF ALGAL PENETRATION THROUGH RAPID-GRAVITY FILTER BED.
A. Watson.
Journal of the Institution of Water and Environmental Management JIWM, Vol. 3, No. 5, p. 443-450, October 1989. 8 fig, 5 tab, 9 ref.

Descriptors: *Gravity filters, *Activated carbon, *Sand filters, *Filter media, *Water treatment, *Taste-producing algae, Turbidity, Particulate matter, Organic carbon, Iron, Odor control, Coal, Chlorine, Hydrogen ion concentration, Zooplankton, Performance evaluation.

Four filter media were evaluated in various filter configurations for their ability to remove algae, particulate organic carbon, iron, turbidity, and chlorine from influent water to the Grahm Water Treatment Works. Filter 1 contained fine granular activated carbon (GAC), Filter 2 was a combination of anthracite and sand, Filter 3 consisted of coarse GAC/sand, and Filter 4 was a mixture of anthracite/sand/garnet. Granular activated carbon performed marginally less well than anthracite/sand or anthracite/sand or anthracite/sand/garnet in the removal of algae, particulate organic carbon, iron and turbidity. The lengths of run achieved by the two granular activated carbon filters were shorter than those of the other two media. A three-layer filter is better than the anthracite/sand filter for particulate organic carbon, iron and turbidity removal, and the filtrate of this filter configuration contained lower mean concentrations of algae. Penetration of *Cyclops strenuus* was greatest through the fine GAC filter, and there were virtually no *Cyclops* found in the three-layer filtrate. After an initially higher level of penetration through the anthracite/sand filter than the coarse GAC/sand filter, these two media showed little difference in the second half of the year. (Geiger-PTT)
W90-05010

INSTRUMENTATION, CONTROL AND AUTOMATION: THE GRAMPAN WAY.
Grampian Regional Council, Aberdeen (Scotland). Dept. of Water Services.
A. L. Gordon.
Journal of the Institution of Water and Environmental Management JIWM, Vol. 3, No. 5, p. 459-464, October 1989. 3 fig.

Descriptors: *Instrumentation, *Scotland, *Warning systems, *Telemetry, *Water treatment facilities, *Automation, *Process control, Reservoir operation, Water treatment, Computers.

A regional telemetry scheme was initiated at northeastern Scotland's Turiff water treatment works to replace the existing process control computer which could not be economically repaired in the event of a major breakdown. The new system was given an envelope of predicted values, which when exceeded would produce an alarm. This philosophy was extended to cover control of pumps, using reservoir levels. The contract to install the new telemetry system covered not only the equipment needed to replace the Turiff computer and its satellites, but also divisional master stations at Fraserburgh and Inverurie so that information could be passed to the operations rooms there. A telephone network was chosen to allow connection of outstations as added and required. The information initially provided in the contract on power requirements for the telemetry system was insufficient and upgraded equipment had to be provided. The new system was fully operational by July 1988. Under the new telemetry system if an alarm occurs, an outstation will try to contact its master station or take fail safe measures when an alarm cannot be answered. (Geiger-PTT)
W90-05012

TAMING A RIVER WITH NEW TECHNOLOGY.
For primary bibliographic entry see Field 4A.
W90-05015

MODELING FOR CLASS-I SEDIMENTATION.
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-05026

ASSESSMENT IN RATS OF THE GONADO-TOXIC AND HEPATORENAL TOXIC POTENTIAL OF DIBROMOCHLOROPROPANE (DBCP) IN DRINKING WATER.
National Toxicology Program, Research Triangle Park, NC.
J. J. Heindel, A. S. Berkowitz, G. Kyle, R. Luthra, and J. V. Bruckner.
Fundamental and Applied Toxicology FAATDF, Vol. 13, No. 4, p. 804-815, November 1989. 2 fig, 5 tab, 37 ref.

Descriptors: *Chlorinated hydrocarbons, *Toxicity, *Bioassay, *Drinking water, *Dibromochloropropane, Blood, Liver, Rats, Animal physiology, Tests.

This investigation was undertaken to assess the potential of ingested 1,2-dibromo-3-chloropropane (DBCP) to cause testicular and hepatorenal injury, in light of the paucity of data applicable to risk assessment of DBCP in drinking water. Adult male Sprague-Dawley rats were supplied ad libitum with water containing 0, 5, 50, 100, and 200 ppm DBCP for 64 days. A dose-related decrease in water consumption occurred during the study. The 200-ppm animals drank less than half as much water as controls, consumed less food, and subsequently exhibited significantly lower body weight gain. Average daily intake of DBCP for the 64-day exposure period was as follows: 5 ppm=0.4 mg/kg/day; 50 ppm=3.3 mg/kg/day; 100 ppm=5.4 mg/kg/day; 200 ppm=9.7 mg/kg/day. Blood samples were taken after 2, 4, and 6 weeks of exposure and at the terminal sacrifice and assayed for serum glutamic-oxaloacetic transaminase, glutamic-pyruvic transaminase, sorbitol dehydrogenase, and ornithine-carbamyl transferase activities and BUN levels. No evidence of liver damage at any exposure level was indicated by either the clinical chemistry indices or histopathology. Histologic examination revealed an apparent increase in the number of nuclei per renal proximal tubule cross-section in the 200-ppm group, possibly indicative of an increased turnover of proximal tubular cells. A slight, but statistically significant, decrease in absolute testicular weight was manifest in the 200-ppm animals, although the decrease was not significant when testicular weight was calculated as g/100 g body wt. Epididymal sperm counts and serum luteinizing hormone, follicle stimulating hormone, and intratesticular testosterone levels were not altered by any dose of DBCP. A qualitative histopathological examination of the testicular seminiferous epithelium failed to reveal any abnormalities in the spermatogenic process. (Author's abstract)
W90-05046

OVERVIEW OF CONTAMINANT HYDROLOGY, GEOCHEMISTRY, AND MICROBIOLOGY AT THE CAPE COD TOXIC WASTE RESEARCH SITE.
Geological Survey, Marlborough, MA.
For primary bibliographic entry see Field 5B.
W90-05074

DEVELOPMENT OF THE PIPE LOOP SYSTEM FOR DETERMINING EFFECTIVENESS OF CORROSION CONTROL CHEMICALS IN POTABLE WATER SYSTEMS.
Construction Engineering Research Lab. (Army), Champaign, IL.
T. M. Prakash, R. J. Scholze, C. H. Neff, S. W. Maloney, and M. Heath.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 105. Price codes: A04 in paper copy, A01 in microfiche. USA-CERL Technical Report N-88/12, August 1988. 56p, 15 fig, 11 tab, 54 ref.

Descriptors: *Testing procedures, *Potable water, *Corrosion control, *Water conveyance, *Pipes, *Water quality control, Maintenance, Steel, Water quality, Fort Bragg, Fort Monroe.

In the Army's 12,000 miles of water lines, internal corrosion slowly destroys a large investment and creates significant problems for Army water treatment plant operators, who try to maintain the water quality at acceptable levels. Corrosion can be slowed using corrosion-inhibiting chemicals, but it is difficult to measure the extent of corrosion and the effectiveness of inhibitors without excavating actual pipes. This study surveyed corrosion-inhibiting water quality control chemicals and methods for monitoring corrosion. With this knowledge, a pipe loop system was developed and installed at Fort Bragg, NC and Fort Monroe, VA. The pipe loop system consists of common, commercially available components, installed compactly on a 4 ft by 4 ft plywood sheet. Using it, several metal coupons and lengths of pipe can be exposed to water at a particular stage in the treatment process. The system's standard, multispecimen design lends itself to a multitude of experimental designs, but it is especially suited for side-by-side, simultaneous testing. Corrosion rates are measured using the weight loss methods specified in ASTM Standard D-2688-83. Preliminary results reported are: corrosion rates—at both installations, pipe inserts corroded faster than coupons which were exposed to the same water. At Fort Monroe, the coupons corroded less in the water treated with corrosion inhibitor, but no difference could be determined for the pipes. At Fort Bragg, the corrosion rate appeared to be greater for specimens in treated water; type of corrosion—mild steel specimens exhibited significant pitting. The corrosion of the galvanized steel specimens was more general; and 'Red Water' problems—at Fort Bragg the normal corrosion inhibiting treatment seemed to prevent 'red water,' while at Fort Monroe it did not. (Lantz-PTT)
W90-05148

COMPTRAIN GUIDE: A MANUAL FOR IMPROVING THE PERFORMANCE OF SMALL WATER AND WASTEWATER SYSTEMS.
National Demonstration Water Project, Washington, DC.
For primary bibliographic entry see Field 5D.
W90-05163

WATER RESOURCES OF SOLEDAD, POWAY, AND MOOSA BASINS, SAN DIEGO COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 5D.
W90-05274

CORROSIVE GROUNDWATER IN THE KIRKWOOD-COHANSEY AQUIFER SYSTEM IN THE VICINITY OF OCEAN COUNTY, EAST-CENTRAL NEW JERSEY.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-05275

EVALUATING WATER AND SANITATION PROJECTS: LESSONS FROM IMO STATE, NIGERIA.
Health Policy and Planning, Vol. 4, No. 1, p. 40.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5F—Water Treatment and Quality Alteration

49, March 1989, 19 ref.

Descriptors: *Drinking water, *Nigeria, *Public health, *Sanitation, *Africa, *Water treatment, Boreholes, Education, Developing countries, Human diseases, Water pollution control.

The Imo State Drinking Water Supply and Sanitation Project in Nigeria was a pilot study launched in late 1982. In the three intervention villages, the project installed boreholes with handpumps, promoted ventilated improved pit latrines, provided health and hygiene education through village-based workers and encouraged a high level of community involvement. An evaluation of the health impact was an integral part of the project's implementation and was based on a quasi-experimental design with two control villages. The evaluation used both longitudinal and cross-sectional surveys to collect information over the 3 1/2 year period covering the pre-, peri-, and post-intervention periods. Diarrhea and dracunculiasis (guinea worm disease) were the main health indicators studied. In addition a wide range of intervening variables was also examined. The project experienced a number of difficulties with implementation, particularly with regard to the sanitation and educational components, because of the experimental approach and emphasis on community involvement. Due to the widespread use of water from boreholes, the project showed an impact on dracunculiasis. The impact on diarrhea was not clearly shown although some water-associated behavior was associated with a lower risk of diarrhea in the intervention villages. The prevalence of wasting (under 80% weight-for-height) among children under three years of age decreased significantly over time in the intervention but not in the control villages. The lessons learned from the health impact evaluation have important implications for future studies. (Author's abstract) W90-05285

PRIMARY HEALTH CARE: WHY HAS WATER BEEN NEGLECTED.

Research Triangle Inst., Durham, NC.
M. Yacobi, W. Brieger, and S. Watts.
Health Policy and Planning, Vol. 4, No. 4, p. 328-333, December 1989, 22 ref. US Agency for International Development Contract No. 5942-C-00-4085-00.

Descriptors: *Water treatment, *Public health, *Developing countries, *Water supply development, Water pollution control, Water resources management.

Since primary health care became 'selective' the need for clean water sources has largely been neglected. This paper highlights both the economic and philosophical necessity to look again at the approach to primary health care. An observational study from Nigeria is used to exemplify a community where a clean water source was the most urgent need, yet was ignored. Guinea worm infestation therefore caused serious disability in the community and resulted in a reduced uptake of the very forms of 'selective' primary health care that have been favored internationally—breastfeeding, immunizations, malaria treatment and oral rehydration therapy. In particular, the effect of such disability on women—who have prime responsibility for the health and welfare of their families—was seriously underestimated, to the detriment of child health and survival. A clean, convenient water supply should be an essential component of primary health care. (Author's abstract) W90-05286

EFFECT OF PARTICLE SIZE AND BACKGROUND NATURAL ORGANICS ON THE ADSORPTION EFFICIENCY OF PAC.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
I. N. Najm, V. L. Snoeyink, M. T. Suidan, C. H. Lee, and Y. Richard.
Journal of the American Water Works Association JAWWA, Vol. 82, No. 1, p. 65-72, January 1990, 9 figs, 2 tab, 33 ref.

Descriptors: *Water treatment, *Activated carbon, *Humic substances, Powdered activated carbon,

Removal efficiency, Trichlorophenol, Groundwater.

The objectives of this study were to determine the efficiency of adsorption of powdered activated carbon (PAC) for a typical synthetic organic chemical, to evaluate the importance of particle size and background organics, and to develop a procedure to predict the performance of PAC. Results showed that performance can be significantly improved by using smaller-size PAC but that the rate of adsorption and PAC capacity are markedly reduced when naturally occurring humic substances are present in the groundwater. Accurate predictions of the removal of trace organics by PAC in a continuously stirred tank reactor were made by running equilibrium and closed-batch kinetic tests, determining equilibrium and kinetic constants, and using an equation to determine the removal efficiency of the PAC for any contact time. The removal of 500 microg 2,4,6-trichlorophenol (TCP)/L from groundwater by 25 mg PAC/L in the completely mixed slurry reactor was predicted to drop from 75.4 to 38.7 percent for a contact time of 20 min. in the presence of humic substances. (Author's abstract) W90-05292

DROUGHT MANAGEMENT OF EXISTING WATER SUPPLY SYSTEM.

Water Resources Management, Inc., Columbia, MD.
D. Randall, M. H. Houck, and J. R. Wright.
Journal of Water Resources Planning and Management (ASCE) JWRMD, Vol. 116, No. 1, p. 1-20, January/February 1990, 16 fig, 2 tab, 15 ref, 3 append.

Descriptors: *Water treatment facilities, *Drought, *Water conservation, Model studies, Case studies, Indianapolis.

A multi-objective linear program is developed to study the operation of a metropolitan water supply system during drought. The Indianapolis Water Company is used as a case study. Twelve pressure districts, three reservoirs, and eight supply sources are included in the model. Four noncommensurate and conflicting objectives identified and built into the linear program include maximization of: (1) net revenue; (2) reliability; (3) storage at the end of the optimization horizon; and (4) streamflows. The model is used to analyze operations during the drought of record and to develop trade-off curves among the objectives. The model consists of five fundamental components: a pumping-cost-by-pressure-district model; a streamflow generation model; a reservoir loss model; a daily district demand model; and a well field model. With some modifications, the model can be used to analyze short-term operation. In addition, the model can be used to find 'bottle necks' in the system, and determine the effect of modifications to the system. (Author's abstract) W90-05299

COMPARISON OF ALUMINIUM PREPARATIONS AS COAGULANTS IN WATER TREATMENT.

Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
C. Yao, and C. R. O'Melia.
Aqua AQUAAA, Vol. 30, No. 6, p. 339-344, December 1989, 1 fig, 12 ref.

Descriptors: *Aluminum chloride, *Alum, *Chemical coagulation, *Water treatment, Particulate matter, Dissolved solids, Turbidity, Humic acids, Fulvic acids, Sulfates, Ions.

In conventional water treatment systems, the removal of particulate and dissolved materials is determined primarily by the effectiveness of coagulation. When alum ($Al_2(SO_4)_3 \cdot 14.3H_2O$) is used in coagulation, the actual coagulant species that are operative in the process are formed during and after the alum is mixed with the water to be treated; $Al(++)$ and $SO_4(-)$ are not directly involved in the coagulation process. Laboratory experiments were conducted to compare the effectiveness of four aluminum preparations in the co-

agulation of synthetic waters containing turbidity and natural organic matter, at two pH levels (5.5 and 7.0) and two temperatures (20 and 4 C). Two partially neutralized solutions of aluminum chloride (PACI) were used together with alum and unneutralized aluminum chloride. The results indicate that partially neutralized solutions of aluminum chloride are effective at lower dosages than other aluminum preparations for the coagulation of high-turbidity waters, particularly at low temperatures or acidic pHs. Among the aluminum coagulants tested, alum is the choice for the coagulation and sedimentation of most other waters. This includes supplies with low turbidity and also waters containing humic substances. Both preparations reacted with humic substances, but alum provided better removals of fulvic acid at lower dosages in jar tests. It is suggested that the sulfate present in alum is an important factor in the removal of humic substances by aluminum. (VerNooy-PIT) W90-05315

MATHEMATICAL MODELLING OF WATER DISTRIBUTION NETWORKS UNDER STEADY-STATE CONDITIONS: RECENT DEVELOPMENTS AND FUTURE PROJECTS, (MODELLISATION DES RESEAUX DE DISTRIBUTION D'EAU EN REGIME PERMANENT: EVOLUTIONS RECENTES ET PERSPECTIVES).

Societe Anonyme Francaise d'Etudes, de Gestion, et d'Enterprise, Nanterre (France).
B. Bos, and P. A. Jarrige.
Aqua AQUAAA, Vol. 30, No. 6, p. 352-357, December 1989, 2 ref. English summary.

Descriptors: *Mathematical models, *Water distribution, *Computer models, *Network design, Computers, Simulation analysis, Water management, Algorithms, Graphical analysis, Future planning.

This article points out the advantages of mathematical modeling of a water distribution system as well as the difficulties connected with obtaining a truly representative model. It then reviews the past evolution of software for analysis of water distribution networks under steady-state conditions. By means of an example, a demonstration is made of the development taking place using tools having greatly improved performance. Areas of progress include calculation speed, facility of access, and most importantly, facilities available to the user for rapidly analyzing results of the simulations using elective and advanced presentations on a color visual display unit. After a brief review of the new applications of this software, particularly for computer-aided decision making, the prospects of future development are examined, with special reference to the field of water quality in the networks. (Author's abstract) W90-05317

WATER SUPPLY AND SANITATION IN RURAL DEVELOPMENT AID COOPERATION PROGRAMMES.

Helsinki Univ. (Finland). Dept. of Limnology.
P. Lehmusluoto.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p. 75-81, 1989, 2 fig, 1 tab, 24 ref.

Descriptors: *Developing countries, *Diseases, *Water supply, *Sanitation, Cost analysis, Economic aspects, Public health, Political aspects, Governmental interrelations.

Many health-related problems can be largely attributed to inadequate water supply and sanitation services. The present contributions and activities in this sector fail to ensure minimum services to a large proportion of rural people in the developing world. The first half of the International Drinking Water Supply and Sanitation Decade (IDWSSD) has failed to observe any appreciable increase in the coverage of the services. In fact, sanitation services have actually decreased and morbidity, disability and mortality rates are high, due to the prevalence of disease. Recent technical interventions are only a part of multiple and complex development processes, which should primarily be

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focused on the consumer. The project cycle concept may be relevant in project follow-up, but it may be of minor importance in impact evaluation. Programs and projects should have a wider scope and take into account the sustainability and viability of the services provided by the investments. The preparation and planning of programs and the cost-recovery issues in the context of grant aid may need reconsideration (Author's abstract).
W90-05347

DETECTION OF COLIPHAGES AND ENTEROVIRUSES IN DRINKING WATER AND ITS SOURCES.

Vyskumny Ustav Preventivneho Lekarstva, Bratislava (Czechoslovakia).
For primary bibliographic entry see Field 5A.
W90-05481

5G. Water Quality Control

ECONOMIC TARGETING OF NONPOINT POLLUTION ABATEMENT FOR FISH HABITAT PROTECTION.

Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
J. B. Braden, E. E. Herricks, and R. S. Larson. Water Resources Research WRERAQ, Vol. 25, No. 12, p 2399-2405, December 1989. 3 fig, 40 ref.
Illinois-Indiana Sea Grant Program project SG-083 and Agricultural Experiment Station, College of Agriculture, University of Illinois, project 0334.

Descriptors: *Model studies, *Water pollution control, *Watershed management, *Fisheries, *Agricultural runoff, Fish habitats, Farm management, Economic aspects, Model studies, Michigan.

A model is presented which relates farm economics, pollutant delivery, fisheries habitat quality and reliability, and spatial optimization. The model identifies the most profitable cropping practices which provide an acceptable level of risk of impairment to the physical and chemical fish habitat. The potential of the model as a watershed management aid is demonstrated with an application to salmonid habitat in a Lake Michigan tributary. The 93-ha site in Berrien Co., Michigan was divided into nine catchments containing 19 land management units (LMUs). Each of the twelve farm management alternatives included one of three tillage practices (conventional, conservation, and no-till), one of two crop rotations, and one of two mechanical practices (vertical plowing and contour plowing). The three most heavily used pesticides were considered: atrazine, carbofuran, and cyanazine. All three are used in varying amounts in all management alternatives. The results indicate that selective tillage changes constitute an optimal approach to habitat protection at modest levels of quality and reliability but are a poor approach for high quality and reliability because of pesticide effects. Those effects are best addressed with a mixture of crop and cultivation changes rather than tillage changes alone. (Author's abstract)
W90-04657

TOXICOLOGY STUDIES OF A CHEMICAL MIXTURE OF 25 GROUNDWATER CONTAMINANTS: II. IMMUNOSUPPRESSION IN B6C3F MICE.

National Toxicology Program, Research Triangle Park, NC.
For primary bibliographic entry see Field 5C.
W90-04698

SEQUENCING BATCH REACTOR ACTIVATED SLUDGE PROCESSES FOR THE TREATMENT OF MUNICIPAL LANDFILL LEACHATE. REMOVAL OF NITROGEN AND REFRACTORY ORGANIC COMPOUNDS.

National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 5D.
W90-04737

BIOPHYSICAL TREATMENT FACILITY FOR HAZARDOUS WASTE LANDFILL LEACHATES.

BKK Corp., West Covina, CA. Landfill Div.
For primary bibliographic entry see Field 5D.
W90-04738

ROLE OF SULFATE-REDUCING BACTERIA IN THE ESTABLISHMENT OF THE METHANOGENIC PHASE OF REFUSE STABILIZATION.

Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-04747

DEVELOPMENT OF DIALOG SYSTEM MODEL FOR EUTROPHICATION CONTROL BETWEEN DISCHARGING RIVER BASIN AND RECEIVING WATER BODY - CASE STUDY OF LAKE SAGAMI (JAPAN).

Tokyo Univ. (Japan). Inst. of Industrial Science.
M. Suzuki, K. Chihara, M. Okada, H. Kawashima, and S. Hoshino.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1821-1824, 1989. 2 fig, 1 ref.

Descriptors: *Water pollution control, *Water quality control, *Lakes, *Model studies, *Computer programs, *Pollution load, *Eutrophication, Lake Sagami, Japan, Expert systems, Water management, River basins, Mathematical models.

An expert system was used to estimate the present water quality status of a typical polluted river basin, the Katsura, which flows into Lake Sagami. The functions of the expert system include the following: (1) input of data on river basins, administrative districts, and pollutant sources; (2) input of data on pollutant load per unit activity of sources, numbers or areas of pollutant sources, and rate of pollutant load discharge; (3) calculation and summation; (4) reference database and tutorial; (5) estimation of pollutant load runoff; and (6) estimation of water quality of a receiving body of water. Water quality in the lake (total phosphorus and chlorophyll) was simulated by using total runoff, measured flow rate, and lake volume. Comparison with measured values coincided almost exactly with the actual measurements. (Cassar-PTT)
W90-04780

REMOVAL OF THE GROUNDWATER POLLUTION BELOW AN ABANDONED WASTE OIL REFINERY.

Trischler (Dr.) and Partner, Darmstadt (Germany, F.R.).
P. Ripper, and H. Fruchtenicht.
Water Science and Technology WSTED4, Vol 21, No. 12, p 1841-1844, 1989. 5 fig.

Descriptors: *Water pollution treatment, *Oily water, *Groundwater pollution, *Oil pollution, Hydrocarbons, Chlorinated hydrocarbons, Soil treatment, Aquifers, Geohydrology, Rehabilitation, Wells, Organic compounds, Activated carbon, Flocculation, Sedimentation, Sludge drying.

Investigations of a waste oil treatment site active for about 40 years near Hanau, Germany, revealed a waste oil layer up to 70 cm thick floating on the groundwater about 3.5 m below the surface. The oil contained up to 40 g/l of chlorinated hydrocarbons. Aromatic solvents were also present. The water beneath the oily layer was saturated with soluble organic solvents. The rehabilitation project involves wells to lower the groundwater table so that oily water flows toward a pumping well. The contaminated water is treated in a plant comprised of a separator for floating and settleable materials, a stripping column for volatile substances, activated carbon treatment of exhaust air, and treatment of water from the stripping column by flocculation. Pulverized activated carbon is added to adsorb remaining organic compounds and to prepare the floc for settling. The floc is treated in a sedimentation plant, and the sludge is dewatered in chamber filter presses. (Cassar-PTT)
W90-04785

EUTROPHICATION IN THE NETHERLANDS.

Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
For primary bibliographic entry see Field 5C.
W90-04799

RIVER QUALITY MODELING: FREQUENCY DOMAIN APPROACH.

California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W90-04821

GREAT LAKES WATER QUALITY AGREEMENT.

Limno-Tech, Inc., Ann Arbor, MI.
For primary bibliographic entry see Field 2H.
W90-04875

AGRICULTURAL CONTAMINATION: PROBLEMS AND SOLUTIONS.

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 5B.
W90-04876

CORRECTING WIDESPREAD CADMIUM CONTAMINATION.

Ohio State Univ., Columbus. Dept. of Agronomy.
T. J. Logan, and D. E. Cassler.
Water Environment and Technology, Vol. 1, No. 2, p 312-315, October 1989. 2 tab.

Descriptors: *Water pollution control, *Cadmium, *Soil contamination, *Sludge disposal, *Fertilizers, *Sludge utilization, Agriculture.

In 1964, farmers in a small Pennsylvania town began applying liquid anaerobically digested sludge to their fields. Additionally, sludge continued to be dried in open beds and was readily available to anyone on request and widely used in the community. Nineteen years after sludge application began, the community discovered that it had unknowingly created a serious soil contamination problem. The accumulation of heavy metals, especially cadmium, is one of the greatest concerns associated with sludge application. An example of one farm burdened with cadmium contamination and the lawsuit involved is presented. Methods used for determining the extent of contamination and keeping track of areas that use sludge include: 1) mapping the area, 2) sampling and analysis, 3) notice and remediation, and 4) program evaluation. These results will be used for recommendations for treatment of other contaminated sites. (Male-PTT)
W90-04879

WATER QUALITY INDEX FOR RIVER MANAGEMENT.

M. A. House.
Journal of the Institution of Water Engineers and Scientists IIWSDI, Vol. 3, No. 4, p 336-344, August 1989. 3 fig, 7 tab, 16 ref. Research awards received from the Natural Environment Research Council and from the National Advisory Body for Public Sector Higher Education.

Descriptors: *Pollution index, *Stream pollution, *Water quality, Water quality standards, *Rivers, *Water pollution control.

The theoretical basis underlying the development of a new series of water quality indices is outlined. The main features of their development are the incorporation of legally adopted water quality standards and criteria and the inclusion of information on potential water use and toxic determinands directly within their structural format. Thus an indication of a change in the economic potential of a river through a gradual change in water quality (and hence water use) can be obtained. The General Water Quality Index (WQI) has been applied to all the data for an annual or longer time series as a means of detecting cycles and trends in river water quality. An examination of the lowest determinand ratings for each data set highlights the specific

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determinand(s) responsible for these deteriorations. A 5 percentile WQI score has been calculated for the time series of data and 90 percent upper and lower confidence limits calculated around this score. The results of these applications indicate the ability of the index accurately to reflect both changes in water quality and potential water use. (Author's abstract)
W90-04904

USE OF MIXING ZONE TO DERIVE A TOXICITY TEST CONSENT CONDITION.

Clyde River Purification Board, East Kilbride (Scotland).
A. J. N. Haig, J. C. Curran, C. J. Redshaw, and R. Kerr.
Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 3, No. 4, p 356-363, August 1989. 3 fig, 3 tab, 16 ref.

Descriptors: *Toxic wastes, *Water quality control, *Wastewater disposal, *Legal aspects, *Wastewater disposal, *Toxicity, *Licensing, Scotland, Pollutant identification, Chemical wastes, Bioassay, Water currents, Model studies.

This paper describes how the Clyde River Purification Board (the regulatory authority) and Beecham Pharmaceuticals (the identified discharger) agreed and adopted a novel means of controlling a pharmaceutical plant effluent which is discharged to Irvine Bay, Scotland. Control was achieved by means of a consent (license) condition requiring compliance with a laboratory test of acute toxicity, which was added to the more orthodox conditions already imposed upon the discharge. The new condition was derived using the concept, explicit in the environmental quality objective/environmental quality standard approach to pollution control, of an allowable mixing zone around the outfall. The derivation and validation of the condition necessitated laboratory and field bioassay, current measurements and dye releases, and the use of a plume development model. (Author's abstract)
W90-04907

TRADE EFFLUENT CONTROL: PROSPECTS FOR THE 1990S.

R. R. Martindale, and G. Lane.
Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 3, No. 4, p 387-396, August 1989. 10 ref.

Descriptors: *Water quality control, *Industrial wastes, *Future planning, *Water pollution control, *United Kingdom, Privatization, Costs, Legislation, Effluents, Environmental protection, Administrative agencies, Wastewater facilities, Prediction.

Dischargers of industrial effluents can expect major changes both in the cost of disposing of their effluents and in the legislative controls which will restrict their content. These trends are based on a number of factors: (1) the proposed privatization of the ten regional water authorities, (2) the accompanying reorganization of water pollution control responsibilities between the new National Rivers Authority and Her Majesty's Pollution Inspectorate, (3) the ever-tightening environmental standards for the aquatic environment emanating from European Community headquarters, and (4) general environmental pressures. The various factors which will influence the management of trade effluents in the 1990s are examined and some indication is given of what the future holds both in terms of disposal costs and environmental regulation from the point of view of the discharger. For the first time, the responsibility for the control of the quality of industrial effluents discharged to the sewer will be substantially divorced from the responsibility for treating biological and solids loads. In the past the objective has been to ensure that the constituents of discharges are reduced to levels at which they avoid creating an unacceptable level of environmental damage; in the future the objective will be to try to reduce the discharge of any contaminant, as far as is economically practicable, to a minimum. Privatization will establish an entirely new relationship between the discharger and those operating sewage treatment. Effluent dis-

charge will cost a great deal more over the forthcoming decade. We are facing what can reasonably be described as a new era. (Author's abstract)
W90-04910

RESTORING THE GREAT LAKES.

For primary bibliographic entry see Field 2H.
W90-04925

HOW CANADA CONTROLS GREAT LAKES POLLUTION.

J. D. Kingham.
EPA Journal, Vol. 11, No. 2, p 9-10, March 1985.

Descriptors: *Lakes, *Great Lakes, *Canada, *Water law, *Phosphorus, *Water pollution control, *Water quality control, *Chemical wastes, *Monitoring, International Joint Commission, Great Lakes Water Quality Agreement, Canada Water Act, Polychlorinated biphenyls, Gulls, Eggs.

The major threats to the Great Lakes are changes in water levels, eutrophication, and toxic chemical contamination. These problems were recognized by the International Joint Commission, and eutrophication and toxic discharges were dealt with in the 1972 and 1978 versions of the U.S.-Canadian Great Lakes Water Quality Agreement. Progress with respect to lake water levels has demonstrated the extent of cooperation that exists between Canada and the U.S. Attempts to control eutrophication have also been encouraging. The toxic chemical problem has proven very difficult, however. The single most dramatic act for the reduction of phosphorus in the Great Lakes was that of the Canadian federal government's regulation of phosphorus in household laundry detergents under the Canada Water Act of 1972. A significant comeback in fish species has been observed since 1972. Steps to reduce toxic chemicals in the Great Lakes include Canada's ban on control of toxic chemicals such as PCBs and mirex in 1977. An innovative approach that Canadians adopted for detection of low levels of toxic chemicals in the Great Lakes was a program that monitored toxic compounds in herring gull eggs. The Great Lakes Water Quality Board has proposed new, more rigorous approaches to toxic chemical cleanup in geographical areas of concern. The most powerful pollution prevention tool may be the Canadian Fisheries Act. Under this act it is an offense to put any quantity of a substance that might be harmful to fish in any waters that are frequented by fish. Continued cooperation between the Canadian federal and provincial governments will lead to improved water quality in the Great Lakes. Cooperation between the U.S. and Canada will lead to even greater improvements. (Mertz-PTT)
W90-04927

THINKING ECOLOGICALLY IN LAKES PROTECTION.

For primary bibliographic entry see Field 2H.
W90-04929

NONPOINT SOURCE POLLUTION CONTROL EFFECTIVENESS OF RIPARIAN FORESTS ALONG A COASTAL PLAIN RIVER.

East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
J. D. Phillips.

Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 221-237, October 1989. 1 fig, 5 tab, 33 ref.

Descriptors: *Rivers, *Riparian vegetation, *Coastal plains, *Path of pollutants, *Nonpoint pollution sources, *Water pollution control, *Agricultural runoff, *Vegetation effects, *Forests, Topography, Nitrates, Water quality control, Water pollution prevention, Detention time, Soil properties, Model studies, Soil types, Surface runoff, Sub-surface drainage.

A detention-time model of water quality buffer zones was used to evaluate the nonpoint source pollution control effectiveness of riparian forests in a two-county area of the lower Tar River basin, North Carolina. Soil map units, which represent

specific combinations of soil, topography, and vegetation characteristics, were compared in terms of their relative ability to filter nitrate in agricultural runoff. All typical riparian forests provided significant water quality protection, but there was a wide variation in buffer effectiveness. This suggests a need for flexibility in determining buffer widths. A range of 15-80 m is appropriate for the soil-landform-vegetation complexes found in riparian zones within the study area. Buffer widths of 60 m and often much less are generally adequate on the soils likely to be used for agricultural production. (Author's abstract)
W90-04999

EC DIRECTIVE ON THE CONTROL OF DANGEROUS SUBSTANCES (7/464/EEC): ITS IMPACT ON THE UK WATER INDUSTRY.

Water Research Centre, Medmenham (England).
A. R. Agg, and T. F. Zabel.
Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 3, No. 5, p 436-442, October 1989. 3 tab, 27 ref.

Descriptors: *European Community, *Water pollution control, *Water pollution prevention, *Hazardous wastes, *Wastewater disposal, *Regulations, *United Kingdom, Water quality, Heavy metals, Organic compounds, Nutrients, Legislation, Administrative agencies, Environmental policy.

The impact on the United Kingdom water industry of EC legislation adopted and proposed for the control of dangerous substances discharged to the aquatic environment is discussed. The new regulations call for increased monitoring of environmental impact, requiring more sophisticated analytical equipment and skilled staff, together with the increased administrative burden to produce reduction programs and set and control consents for dangerous substances. EC Directive 76/464/EEC is the principal measure dealing with dangerous substances in surface waters, and will have increasing significance for the control of individual substances as limit values and environmental quality standards are set for additional List I compounds. The Ministerial Conferences of North Sea countries have resulted in additional initiatives to reduce discharges of chemicals, including nutrients, to the marine environment. Attention will be focused on selected red-list substances identified on the basis of persistence, toxicity and potential for bioaccumulation. Her Majesty's Inspectorate of Pollution has been created to control the disposal of waste in the most efficient and effective way without imposing excessive costs to industry. The emerging environmental policy supports the idea that restrictions to protect one environmental compartment should take into account the effect on other compartments. Her Majesty's Inspectorate of Pollution and the National Rivers Authority will share much of the responsibility for implementing existing and future legislation to improve water quality and safeguard the environment. (Geiger-PTT)
W90-05009

EC BATHING WATER DIRECTIVE: A SAMPLING PROBLEM.

Clyde River Purification Board, East Kilbride (Scotland).
For primary bibliographic entry see Field 5A.
W90-05013

REVIEW OF FARM WASTE POLLUTION.

L. Beck.

Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 3, No. 5, p 467-477, October 1989. 7 fig, 2 tab, 34 ref.

Descriptors: *Water pollution sources, *Nonpoint pollution sources, *Agricultural runoff, *Farm wastes, *Water pollution control, Pesticides, Water pollution prevention, Feedlot runoff, Feedlot wastes, Silage, Regulations, Legal aspects, Wastewater treatment, Anaerobic digestion, Aerobic treatment, Fertilizers, Food-processing wastes.

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Post-war agricultural practices in England led to greater pollution of rivers and groundwater by farm chemicals and farm wastes with little regulation of the same. Few incidents of pollution by agricultural wastes were reported by the river authorities even as late as the early 1960's. Contributions to the agricultural waste problem came from the dairy industry, silage, food-processing industry, livestock industry, and runoff of fertilizers and pesticides during crop production. Since the mid-1960's work has been done on methods of treating farm animal wastes, including anaerobic lagoons, anaerobic digesters, aerobic lagoons, oxidation ditches, extended aeration units, barrier ditches, rotating biological contactors, biological filters, separators, composting, incineration, wet-air oxidation, drying, and various combinations of all or some of these techniques. Silage effluent can be spread on land after dilution or silage liquor may be fed back to cows. Pesticides must be stored in leak-proof containers and end-of-spray residues and tank washings must be applied to land at acceptable application rates. Mixed-drainage systems on farms and poorly constructed holding tanks or containment structures have greatly contributed to pollution incidents involving farm wastes. Many government policies were initiated in the late 1970's and 1980's to deal with the problem of environmental pollution by farm wastes. The Royal Commission on Environmental Pollution made recommendations in 1979, some of which have now been implemented. The House of Commons Environment Committee introduced grant aids to help farmers comply with regulations and set up the Code of Good Agricultural Practice (COPA). The 1989 Water Act extended the COPA initiative to cover the construction of new and extended silage and slurry facilities and provide for the establishment of protection zones, within which specified activities may be forbidden or permitted subject to conditions. The Country Landowners Association, National Farmers Union, Water Authorities, Yorkshire Water's Farm Pollution Campaign of 1988 and Severn-Trent Campaign have also helped to reduce the number of pollution incidents by farm wastes. (Geiger-PTT) W90-05014

DAILY AVERAGE VALUE OF UN-IONIZED AMMONIA FROM FIELD MEASUREMENTS.

For primary bibliographic entry see Field 2H. W90-05031

MEASUREMENT OF UPWELLING FLOW FROM AIR DIFFUSER.

Jones and Stokes Associates, Inc., Sacramento, CA.
R. T. Brown, J. A. Gordon, and C. E. Bohac.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 15, No. 6, p 1269-1275, December 1989. 3 fig, 2 tab, 15 ref.

Descriptors: *Aeration, *Reservoirs, *Upwelling, *Diffusers, *Flow measurement, *Water quality control, Aerators, Bubbles, Flow velocity, Mixing, Dye releases, Diffusion, Performance evaluation, Flow rates, Hydraulic machinery, Mathematical studies.

An evaluation of the upwelling flow of the air bubble diffuser system installed in the Upper Bear Creek reservoir in 1986 was performed by mathematical analysis, by a dye dilution measurement, and by flow-away current velocity measurements. The upwelling flow equations provided reasonable initial estimates. The plume width predicted mathematically would be 3.2 m for Upper Bear Creek conditions, but as the plume splits at the surface, the depth of the flow-away currents would be 1.6 m. The estimated velocity by this approach would be 0.27 m/sec and the upwelling flow would be 10.4 cu m/sec. Field tests using a 20% Rhodamine WT dye solution yielded velocity profiles indicating that the depth of the flow away layer was between 1.5 and 2.5 m, with velocities dropping to less than 0.03 m/sec below this depth. The higher upwelling flow measurements by the dye dilution method were attributed to wind effects and possible mixing with the undyed portion of the plume. Velocity measurements provided another estimate of the upwelled flow. The mean velocity of the 2.5

m depth flow away layer was about 0.17 m/sec for the normal air flow rate, giving an upwelling flow estimate of 10.8 cu m/sec. For the increased air flow rate, the average velocity was 0.22 m/sec, which represents an upwelling flow of 13 cu m/sec. These results might be too low, since the wind was blowing against the flow-away current. The wind may have caused the upwelling plume to split unevenly and flow upwind at a reduced velocity. The dye dilution procedure for measuring the upwelling flow was relatively inexpensive, and the interpretation of results was straightforward. Buyers or installers of reservoir diffuser systems could use the technique to verify the performance of a new installation. (Geiger-PTT) W90-05032

TECHNOLOGY EVALUATION REPORT. SITE PROGRAM DEMONSTRATION TEST, SHIRCO INFRARED INCINERATION SYSTEM, PEAK OIL, BRANDON, FLORIDA. VOLUME I.

Enviresponse, Inc., Livingston, NJ.
S. Rosenthal.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-125991. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/540/5-88/002a, September 1988. 95p, 3 fig, 24 tab. EPA Contract 68-03-3255.

Descriptors: *Cleanup operations, *Oil wastes, *Polychlorinated biphenyls, *Water pollution treatment, *Incineration, Infrared systems, Pollutant identification, Florida, Heavy metals, Organic compounds, Dioxins, Furans, Nitrogen compounds, Inorganic acids, Lead, Ash, Water pollution control, Toxicity, Leaching.

A Shirco Infrared System used for a removal action at a polychlorinated biphenyl (PCB)-containing oil refining waste site in Brandon, Florida (a suburb of Tampa) was evaluated. The evaluation included a determination of toxics in the material being decontaminated as well as all the effluent streams such as ash, air emissions and wastewater. These streams were analyzed for heavy metals, organics, dioxins, furans as well as NOx, and inorganic acids. Leaching tests were performed on the ash. The results indicated that the PCB was reduced from 5 to 100 parts per million (ppm) to < 1 ppm in the ash, which was the purpose of the removal action. Although research had indicated that the lead compounds in the ash would become insoluble because they would be complexed with carbon, the ash could not be considered non-leachable based on the toxicity tests. (Author's abstract) W90-05141

ELEMENTS OF FLOATING-DEBRIS CONTROL SYSTEMS.

Cold Regions Research and Engineering Lab., Hanover, NH.
R. E. Perham.

Available from the National Technical Information Service, Springfield, VA 22161. Technical Report REMR-HY-3, September 1988. Final Report. 66p, 35 fig, 34 ref, 3 append.

Descriptors: *Water pollution treatment, *Detritus, *Flotsam, *Water quality, *Waste disposal, *Damage, Trash racks, Water pollution control.

Floating debris is a continual problem for all users of water bodies. Some of the damage caused by debris is minor, but too often it is quite costly. It is destructive to locks, dams, bridges, electric plants, municipal water systems, and even to recreational boaters. Wetlands, fish-spawning grounds, and streambanks can be disturbed by debris. A floating-debris control system consists of collecting, removing, and disposing of the debris. Various types of booms, trash racks, trash struts, and deflectors have been used effectively for collecting floating debris. Hand-powered, self-powered, and gantry crane-operated rakes are used to remove the debris from intake gates, bulkheads, deck gratings, and trash rack sections. Heavy debris, such as water-soaked logs or fallen trees, are removed with cranes and hoists, supplemented by such implements as bolt hooks, log chains, and chain saws. Some of the removed debris has value. Many logs

are large enough to be used as structural materials: supports for small buildings, guard posts for parking lots, and supports for soil stabilization. Also, some of it can be dried and cut up for firewood. The debris that cannot be used must be burned, buried, or dumped on the ground surface. All of these processes require careful monitoring so that they are not and do not create health hazards. Surface dumping should be used only as a last resort. An effective floating-debris control system requires time, effort, and money; however, its benefits more than offset its requirements. (Lantz-PTT) W90-05142

WATER QUALITY CHANGES CAUSED BY EXTENSION OF THE WINTER NAVIGATION SEASON ON THE DETROIT-ST. CLAIR RIVER SYSTEM.

Cold Regions Research and Engineering Lab., Hanover, NH.
R. S. Sletten.

Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 535. Price codes: A04 in paper copy, A01 in microfiche. Special Report 88-10, July 1988. 56p, 19 fig, 4 tab, 15 ref, append. US Army Corps of Engineers Contract NCE-IS-82-0114.

Descriptors: *Navigable Rivers, *Environmental effects, *Navigation, *Water quality, *St. Clair River, *Detroit River, Seasonal variation, Cold regions, Water temperature, Dissolved oxygen, Turbidity, Suspended solids, Volatile solids, Hydrogen ion concentration, Ships.

This study was conducted to determine how the water quality in the Detroit-St. Clair River System may change if the navigation season is extended from early January to the end of January. The study looked at background water quality, the effects of ship passage, and sedimentation rates. Background water quality in the study area has been continually improving since 1967. There is significant seasonal variation in temperature and dissolved oxygen not related to shipping activity. The background variation in all characteristics studied during this project as reported to the Environmental Protection Agency's STORET system was greater than any observed variation due to ship passages. Although seasonal variation is clearly evident for temperature and dissolved oxygen, no seasonal variation was evident for turbidity, suspended or volatile solids, or pH. It is concluded that natural background variation is greater than and independent of ship-induced variation. (Lantz-PTT) W90-05146

DYNAMIC MODELING AND EXPERT SYSTEMS IN WASTEWATER ENGINEERING.

For primary bibliographic entry see Field 5D. W90-05149

WASTEWATER TREATMENT AND RECEIVING WATER BODY INTERACTIONS.

Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5D. W90-05154

OIL SPILL RESEARCH AND DEVELOPMENT NEEDS FOR THE 1990'S.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
J. S. Farlow, and J. M. Cunningham.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-142665. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/278, January 1989. 14p, 2 tab.

Descriptors: *Water pollution treatment, *Oil spills, *Research priorities, *Water pollution prevention, *Water pollution control, Inland waters, Technology, Handbooks, Maintenance, Public participation, Pipelines, Weirs, Booms, Dispersants, Chemical treatment.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5G—Water Quality Control

In the 1970's and the early 1980's the emphasis of Federally-sponsored oil spill research was on mechanical spill control devices and removal methods such as booms, skimmers, and sorbents, with later efforts also focused on dispersing agents. The preponderance of this work was directed toward oil spills in open ocean and coastal areas. Private research programs and field experience also contributed to the extensive knowledge-base capabilities and limitations of mechanical and chemical oil spill control and cleanup methods. In Fiscal 1988, research and development in prevention and cleanup of oil spills was suspended by the US EPA in favor of other high priority topics. However, recent events have shown that further research is needed on prevention and cleanup methods, especially for inland spills. Innovations developed since the early 1980's have yet to be evaluated in a controlled setting, even in the open sea. Suggested spill prevention, control and countermeasure (SPCC) research for inland rivers, a three-year program, includes: SPCC failure analysis, models to reduce catastrophic tank failures, models for containment systems, rapid leak detection, update SPCC pipeline guidance, update SPCC inspection manual, update SPCC technical guidance protocol for correcting tank system deficiencies, identify high risk areas, contingency planning techniques, and manual for community spill contingency planning. Suggested spill response research for inland rivers, a three-year program, includes: viscosity modifiers, underflow weirs, effective use of dams/locks, use of dispersants, toxicity/effectiveness of dispersants, water intake protection, river characterization, equipment performance testing, near shore cleanup techniques, alternate containment methods, chemical agency evaluation, cold climate control, alternate contracts, existing technology transfer, new technology transfer, and freshwater guidance manual. (Lantz-PTT) W90-05164

ENVIRONMENTAL REGULATION: ITS IMPACT ON INFRASTRUCTURE DECISION MAKING

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div. J. A. Goodrich, and F. T. Mayo. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-142640. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/276, January 1989. 3 p.

Descriptors: *Water treatment, *Water conveyance, *Sewer systems, *Wastewater treatment, *Environmental protection, *Regulations, *Decision making, *Water quality control, Clean Water Act, Safe Drinking Water Act, Legislation, Water conveyance, Pipelines, Economic aspects.

The enactment of laws and regulations related to drinking water quality, surface water discharge limitations, and wastewater treatment goals has required utilities to maintain, upgrade, or even replace their respective underground services. In sewer systems the problem may be excessive infiltration from shallow groundwater and inflow from sources related to storm water stressing the system capacity, or one of corrosion causing the collapse of the pipe walls. The Safe Drinking Water Act (SDWA) of 1974 and its Amendments enacted in 1986 will have a major impact on the cost of treating drinking water, design of distribution systems and compliance monitoring. The amendments require the following action over the next three years: regulation of 83 contaminants (with 25 additional contaminants/year thereafter); filtration of all surface water supplies; disinfection of all water supplies; and significant increases in monitoring requirements. Distribution system design has typically focused on maintaining adequate pressure and hydraulic capacity to meet fire flow demands. Given the recent changes in the SDWA, water quality as it reaches the consumer's tap will become an increasingly important factor in designing new distribution systems or the repair and rehabilitation of portions of a distribution system. The recent Amendments to the Clean Water Act present another set of infrastructure challenges. The move away from outside grants will foster a move toward full-cost recovery pricing which is

currently not the general practice. The recent legislation also makes major changes in the regulation of storm water discharges—runoff from streets and municipal, industrial or other property that carries pollutants into surface waters. (Lantz-PTT) W90-05167

PROCEEDINGS OF THE ENGINEERING FOUNDATION CONFERENCE: GROUNDWATER CONTAMINATION

Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. 193 p. Edited by Yacov Y. Haimes and J. Herbert Snyder.

Descriptors: *Contamination, *Groundwater pollution, *Conferences, *Water pollution control, *Water pollution effects, Monitoring, Public health, Environmental effects, Economic aspects.

Groundwater contamination is by nature multifarious—dealing with detection and monitoring, prevention, abatement and containment, and correction and restoration of contaminated groundwater. It intrinsically encompasses many disciplines, and involves all levels of government. Also, groundwater contamination is complex because decisions concerning groundwater pollution control that are scientifically sound, technologically within the state of the art, economically feasible, politically tractable, legally sustainable, socially acceptable, morally accountable, and organizationally implementable must be grounded on appropriate information and intelligence bases in their respective areas—science, technology, economics, politics, the law, society, ethics, and management. Indeed, the human health effects (e.g., cancer, damage to the central nervous system, liver and kidney damage) and non-health effects (economic hardship to industry, agriculture, households, and municipalities; environmental impacts; social impacts) necessitate that we, as a society, address in a sober way the following variations of the same issue: when is safe, safe enough. The enormous cost—in billions of dollars over the next decade—that various studies project for the prevention, detection and monitoring, abatement and containment, and correction and restoration of groundwater contamination make an answer to these questions even more urgent. (See W90-05170 thru W90-05180) (Lantz-PTT) W90-05169

DISCIPLINARY AND INTERDISCIPLINARY ASPECTS OF GROUNDWATER QUALITY MANAGEMENT: A LAWYER'S PERSPECTIVE

G. D. Weatherford. IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 21-24.

Descriptors: *Political aspects, *Water pollution control, *Water pollution treatment, *Groundwater pollution, *Groundwater quality, *Water quality management, *Legal aspects, Environmental engineering, Zoning, Urbanization, Public health.

It is fashionable to lay the blame for groundwater contamination at the feet of the political system. Since the protection of public health is one of the fundamental roles of government, the inability to insulate drinking water supplies from hazardous wastes does represent government failure. To demonstrate this possible culpability, an example is presented of a hypothetical scene: a growing community in a bucolic valley. As the valley began to show real signs of urbanization, professionals are retained by the city to design a waste collection and treatment system for the community, which at that time seemed amply served by local surface water supplies. Much of the land development in the area was facilitated by lawyers who became very proficient at obtaining rezoning for their clients (who, incidentally, contribute generously and lawfully to the political campaigns of the city council members who consider zoning appeals). Specialized and generalized knowledge is shown to

be very interdependent. However, better disciplinary and interdisciplinary analysis is needed to improve groundwater quality management. If narrow and unimaginative specialization has been part of the problem, so may more inquisitive specialization combined with interdisciplinary analysis become a part of the solution. Interdisciplinary teams can tackle the wide range of issues involved in classifying aquifers, containing plumes by coordinated pumping, and neutralizing trichloroethylene metabolically, for example. (See also W90-05169) (Lantz-PTT) W90-05171

IMPACTS, COSTS, AND TECHNIQUES FOR MITIGATION OF CONTAMINATED GROUNDWATER: A REVIEW

Resources for the Future, Inc., Washington, DC. M. Sharefkin, M. Shechter, and A. Kneese. IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 29-56, 1 fig, 8 tab, 40 ref.

Descriptors: *Cleanup operations, *Costs, *Groundwater pollution, *Water pollution control, Cohansey Aquifer, New Jersey, Economic aspects, Aquifers, Cost-benefit analysis.

A framework is developed for evaluating the impacts, costs, benefits, and techniques for mitigating groundwater contamination. The framework is a generalized cost-benefit analysis. Contamination of the Cohansey aquifer in New Jersey is the subject of an illustrative case study. The plume of contamination is modeled and potential health impacts are projected based on dose-response information available from the Environmental Protection Agency. The economic value of such damages is estimated using alternative mortality risk values that span those found in the recent literature. Costs for controlling the contamination from the site are estimated for alternative levels of control and techniques of control adapting information from the Environmental Protection Agency and other sources. While both the benefits and cost estimates should be mainly viewed as the result of illustrating a method and not as accurate estimates, they do suggest that in a case like the Cohansey, both potential damages (or damages averted, i.e., benefits) and the cost of containment once containment has occurred can be quite high. Prevention in such cases appears to be the best cure. The paper closes with a discussion of the potential role of economic incentives in the generation of hazardous wastes and their 'safe' disposal. (See also W90-05169) (Author's abstract) W90-05172

GROUNDWATER QUALITY MANAGEMENT: THE SEARCH FOR A LEGAL-INSTITUTIONAL FRAMEWORK

G. D. Weatherford. IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 57-64.

Descriptors: *Administrative agencies, *Groundwater quality, *Water quality management, *Legal aspects, Regulations, Federal government, State government, Groundwater pollution, Finances, Interagency cooperation.

Government laws, agencies and programs to protect groundwater quality are growing in response to disclosures of contamination events and threats. Regulatory approaches, involving standard-setting, permitting, and enforcement, continue to be preferred over market approaches. Regulatory authority is dispersed throughout local, state, and federal levels of government, but the site-specific and land-based nature of the problem has put state and local agencies in lead positions. In the aggregate, the regulatory programs appear to suffer from

inadequate information, funding, program coherency, and coordination. As the nature and extent of the contamination problem become better delineated and the technology of prevention and control improves, regulatory gaps will decrease and more positive linkages between local, state, and federal agencies can be expected. (See also W90-05169) (Author's abstract)
W90-05173

FRAMEWORK FOR FUTURE PREVENTION AND MANAGEMENT OF GROUNDWATER CONTAMINATION.

Arizona Univ., Tucson. Dept. of Political Science. H. Ingram.
IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 65-72, 14 ref.

Descriptors: *Groundwater pollution, *Water pollution prevention, *Water quality management, *Environmental protection, *Public participation, *Public opinion, Political aspects, Public policy, Public health, Environmental policy, Institutions, Education.

Public opinion is enormously important in getting an issue like groundwater pollution on the political agenda for action. It is also a very significant factor determining the context in which local water managers must act. A framework for considering the protection of groundwater needs to begin by considering what we know about the structure of public opinion on this issue. When groundwater contamination problems get on the political agenda depends on several factors: (1) the extent of public attention and concern; (2) when the problem is perceived as serious, rather than when it actually becomes serious; and (3) when the public perceives a threat, rather than when enough is known. There is a tendency for the public to believe that whenever water becomes a public issue of the issue signals some failure of government. Media coverage is critical in the development of trust or the lack of it. The key to public reaction, is the manner in which the public is advised of health risks. The framework for action on groundwater must take into account the important role of interest groups and their resources. Environmental interest groups have grown to be among the most vocal and visible in American politics. In comparison with other interest groups, such as labor unions, the overall number of members in environmental organizations is not large. Toxic substances disposal and groundwater contamination are particularly grassroots issues. Contamination events occur in particular places affecting identifiable local populations. In any case, local groups are highly active and citizen observations have been a frequently used means through which hazards have been initially identified. Activities of local groups ranged from identifying, investigating, educating, and organizing to getting action on local public health hazards. National organizations have lagged behind local environmental groups in their concern with toxic substances and groundwater of contamination issues. The orientation and expertise of the leadership of national organizations has been toward the traditional environmental preservation issues and the cleanup of air and surface water. Water professionals must accept environmental groups as an established segment of their constituency. (See also W90-05169) (Lantz-PTT)
W90-05174

EPA GROUND WATER PROTECTION STRATEGY.

Environmental Protection Agency, San Francisco, CA. Region IX.

J. Wise.
IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 73-77.

Descriptors: *Administrative agencies, *Groundwater pollution, *Regulations, *Water pollution

control, Water quality control, Pesticides, State jurisdiction, Underground storage, Water pollution prevention, Federal jurisdiction.

The Environmental Protection Agency's Ground Water Protection Strategy builds on the principle of state control of groundwater; the states have fundamental responsibility for protection and management of the resource itself, while the EPA concentrates on regulating specific contaminants and sources of contamination. This allocation of responsibilities provides a consistent framework within which each party—federal and state—can operate. EPA's Strategy has four objectives, reflecting these mutually supportive responsibilities. They are: (1) to build and enhance groundwater protection programs at the state level; (2) to expand, where appropriate, controls over currently unregulated sources of contamination; (3) to achieve greater consistency in EPA decisions on groundwater and cleanup; a fundamental agency policy will be to set priorities for groundwater protection based on use and vulnerability; and (4) to strengthen EPA's organization for groundwater protection in Washington and in the regions, using key coordinating mechanisms to provide an overall system for focusing on and reviewing policy as it relates to groundwater. Steps are already being taken to implement this strategy. For example: funds are being made available to the states under Section 106 of the Clean Water Act targeted specifically for groundwater protection; an organization, the Office of Ground Water Protection, has been formally established at headquarters in the Office of Water to coordinate the agency's activities and, through the development of appropriate guidelines, to provide a framework for agency activity to protect groundwater; specific action is underway to provide EPA with information on the extent of the leaking underground storage tank problem; for the first time guidelines are being prepared for use within EPA for protection of three classes of groundwater—special groundwater, current and potential sources of water for drinking or other beneficial uses, and waters which are not potential sources of drinking water or other beneficial uses; and a major effort is now underway to address the problem of pesticides in groundwater. (See also W90-05169) (Lantz-PTT)
W90-05175

LOCAL GOVERNMENT AND GROUNDWATER QUALITY MANAGEMENT.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. D. J. Allee, and J. Powell.

IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 79-91, 16 ref.

Descriptors: *Water quality management, *Groundwater quality, *Local governments, *Regulations, *Water pollution prevention, *Groundwater pollution, Water pollution control, Public participation, Education, Public health, Land use.

Regulation is a favorite strategy in resource management to correct spillovers from private activity. For groundwater problems, land use controls are often cited as the long-run solution—presumably because infiltration and recharge rates are highly variable over the landscape, and high-risk land users have little incentive to consider this without controls. Groundwater management involves interactions between land users, each of which may be highly localized initially, but their activities may result in many sources of contamination which, happening over wide chunks of landscape and over long periods of time, provide a ubiquitous threat. The many different federal and state statutes provide some degree of control for each use of these sources. All of these potentially come together at the local level. Two considerations come to mind if local governments are not yet involved in solving or avoiding a problem. First, it may be easier for the different parts of the local government to work together if there is an internal advocate for the problem. Second, stronger local governments

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may end up with more attention, shifting the problem to areas with less capacity to resist and/or less capacity to get help in time. On the smallest scale, regulation is heavily slanted toward education and technical assistance. (See also W90-05169) (Lantz-PTT)
W90-05176

NATIONAL POLICY FOR GROUNDWATER PROTECTION: DOES ONE EXIST.

Virginia Water Resources Research Center, Blacksburg.

W. R. Walker, and P. G. Bridgeman.
IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 93-104, 1 tab, 14 ref.

Descriptors: *Regulations, *Groundwater pollution, *Water pollution control, *Federal jurisdiction, *Public policy, Local governments, Aquifers, Research priorities, Groundwater mining, Groundwater recharge, Coastal zone management, State jurisdiction, Information transfer.

If groundwater is essential to meet the water needs of the future, the fundamental problems which impede its effective use must be examined. The basic groundwater problems facing many regions of the country include the issues of how to manage ground and surface supplies conjunctively, how to deal with quality problems as an integral part of water supply, and how to coordinate state and local responsibilities. If state and local governments are to act responsibly, the federal role must be clearly enunciated in a policy statement with implementing strategies. This paper examines the past activities of the federal government as they relate to groundwater and suggests what its role should be if this portion of the water resource is to help meet the nation's future water needs. Any effective national groundwater policy will be dependent on a series of implementable management strategies at the federal level. These strategies must effectively facilitate and integrate state and local actions. In addition, they must foster cooperation and coordination between federal agencies and programs by use of the budgetary process. The following are recommended components of a national policy to help ensure that the groundwater resources are used efficiently and effectively to meet the national water needs now and in the future: cost sharing; interstate aquifers; groundwater mining and recharge; research; coastal zone program; federal projects; federal support of state projects; information transfer; budget coordination; and work plans. (See also W90-05169) (Lantz-PTT)
W90-05177

RISK ASSESSMENT FOR GROUNDWATER CONTAMINATION.

Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.

Y. Y. Haines, V. Chankong, and C. Du.
IN: Proceedings of the Engineering Foundation Conference: Groundwater Contamination. Co-sponsored by the Universities Council on Water Resources at the Miramar Hotel, Santa Barbara, California, November 11-16, 1984. Engineering Foundation, New York. 1986. p 111-127, 3 fig, 2 tab, 28 ref. Bureau of Reclamation Contract 4-FG-93-00090.

Descriptors: *Groundwater pollution, *Groundwater management, *Water quality management, *Risk assessment, Water pollution control, Water pollution prevention, Decision making, Management planning, Model studies, Computer programs.

This paper focuses on the risk assessment and management process in terms of the ever-present problem of groundwater contamination and its prevention and correction. It provides a definition of terms and concepts in risk assessment and management, develops a short taxonomy of risk assessment

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methodologies, and briefly discusses the imperativeness of multiple-objective optimization in risk assessment and management. To perform the complete process of risk assessment for a particular problem, the following tasks need to be carried out: (1) risk identification; (2) risk quantification; (3) risk evaluation; (4) risk acceptance and aversion; and risk management. A decision support system (DSS) is well-suited for water resources systems in general and for groundwater contamination risk assessment and management in particular. Within the specific context of the latter, the inherent complexity of the groundwater contamination process clearly indicates a great need for an integrated decision support tool that is capable of doing the following: (1) allow the user to define appropriate input configurations related to the pertinent economic, industrial, and demographic conditions of the study area; (2) allow the user to employ the model at different levels of resolution depending on the user's needs and the availability of data; (3) incorporate into the DSS, if possible, the various types of infiltration, flow, and transport models based on the different types of soil and the geologic and hydrologic conditions of the study system in order to add yet another dimension of flexibility; (4) provide an option to perform multiobjective trade-off analysis, systematic sensitivity analysis, and risk assessment; and (5) provide a man-machine interactive mode option to allow planners and decision makers to interact with the model with a quick turn-around time. (See also W90-05169) (Lantz-PTT)
W90-05178

GROUNDWATER HEALTH RISK ASSESSMENT: A CASE STUDY.
California Univ., Los Angeles. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5C.
W90-05179

CONTENT ATTITUDE STUDY OF WATER RELATED TOPICS IN PUERTO RICO DAILY NEWSPAPERS.
Puerto Rico University, Mayaguez, Dept. of Social Sciences.
For primary bibliographic entry see Field 6B.
W90-05196

EVALUATION AND MODELING OF VOLATILE ORGANIC VAPOR TRANSPORT IN THE UNSATURATED ZONE FOR GROUNDWATER QUALITY PROTECTIONS.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5B.
W90-05200

ECONOMIC AND LEGAL ANALYSIS OF STRATEGIES FOR MANAGING AGRICULTURAL POLLUTION OF GROUNDWATER.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
S. S. Batie, R. A. Kramer, and W. E. Cox.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-129131/AS. Price codes: A21 in paper copy, A01 in microfiche. Final report, October 15, 1989. 496p, 3 tab, 22 ref, 4 append. USGS Contract 14-08-0001-G1303.

Descriptors: *Groundwater, *Economic evaluation, *Institutions, *Nitrates, *Leaching, *Linear programming, *Karst, *Water pollution, *Cost sharing, *Simulation analysis, *Water quality, *Farm wastes, *Fertilizers, *Net profit, *Farm management, *Virginia, *Rockingham County, *Manure-storage facilities, *CREAMS model.

The overall objectives were to identify constitutional and legal strategies for the management of groundwater quality, to design alternative state and/or federal strategies for the management of environmental risks associated with agricultural pollution of groundwater, and to estimate first round impacts of farm income, land use, government revenues, and groundwater pollution levels resulting from implementation of alternative management strategies in a case study context. A com-

prehensive review of existing state strategies and available legal mechanisms within constitutional constraints and the federal legal framework was completed. These strategies were used in hypothetical scenarios to reduce nitrate pollution of groundwater from dairy farms in Rockingham County, Virginia. CREAMS, a hydrology sub-model was employed to model physical relationships between changed farming practices and altered chemical leaching magnitudes. Dairy farmers were surveyed as well, and the results were used to create a mathematical programming farm model with which to estimate impacts of alternative management strategies. (USGS)
W90-05233

RESOURCE ALLOCATION AND ENVIRONMENTAL OBJECTIVES. A REGIONAL EVALUATION OF SWEDISH EUTROPHICATION CONTROL POLICY 1965-80.
Linköping Univ. (Sweden). Dept. of Water in Environment and Society.
M. Lowgren.
Journal of Environmental Management
JEVMAW, Vol. 29, No. 4, p. 363-376, December 1989. 2 fig, 3 tab, 25 ref.

Descriptors: *Resource allocation, *Sweden, *Water pollution control, *Eutrophication, *Costs, *Wastewater treatment, *Urban areas, *Biochemical oxygen demand, *Phosphorus.

Subsidized investment costs of measures taken between 1970 and 1980 to protect and restore water quality of four recipients (Lake Vattern, Lake Sommen, Motala River, and the River Svarta) were studied. 'Add-on' investment costs to reduce emissions of phosphorus and biochemical oxygen-demanding substances from municipal wastewater treatment plants, industries and farms were related to specific objectives of water quality. Costs were compared both within and between the sectors of study, thus establishing the cost effectiveness of the actual resource allocation. On average, small-scale removal costs (investment) for phosphorus in the municipal sector were more than 70 times higher than for agricultural emissions of the same magnitude. For biochemical oxygen demand, small-scale investment costs for municipalities were five times higher than that of industry. Scale effects were marked: more than one third (37%) of subsidies to municipal wastewater treatment were granted to small urban areas (<3000 inhabitants) in the river basin, making 9% of the urban population of study. The subsidy policy implemented neither furthered recipient-oriented emission control, nor did it promote innovative technology development. The presence of multiple objectives, which did not assign superior priority to ambient quality objectives, may offer part of the explanation, and the formulation of environmental objectives in a political context are likely to favor measures where benefits were obvious in the short run. (Author's abstract)
W90-05295

DISCHARGER GROUPING FOR WATER QUALITY CONTROL.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. W. Eheart, E. D. Brill, and J. C. Liebman.
Journal of Water Resources Planning and Management (ASCE) JWRMDS, Vol. 116, No. 1, p. 21-37, January/February 1990. 3 fig, 7 tab, 11 ref. EPA cooperative agreement CR-812577-01 and 02.

Descriptors: *Water pollution control, *Water quality management, *Water pollution prevention, *Wastewater disposal, *Statistical methods, *Regulations.

In developing management programs to regulate point sources of waterborne waste, it may be convenient or even necessary to subdivide the dischargers into groups. For simplicity and effectiveness in meeting water quality goals, it is desirable that the regulatory decisions governing one group of dischargers be minimally influenced by those governing other groups. One way to accomplish this is to separate the watercourse into sets of water quality checkpoints such that each set of

checkpoints is associated with a group of dischargers and the effect of the dischargers excluded from a given group upon the checkpoints associated with that group is small. A quantitative method for effecting such groupings is presented. The method minimizes the impacts of the dischargers included in a group on checkpoints associated with other groups of dischargers. A heuristic method is used that consists of: (1) forming the matrix of impact contributions; (2) selecting a criterion for representing the unaccounted impact as a single number; (3) constructing a table of values of this criterion for each possible breakpoint; and (4) considering the table to be values of a dependent variable plotted against two independent variables, and identifying the local minima; which are the potential breakpoints. The method is illustrated using data for several river basins, viz., the Lower Fox River in Wisconsin, the Willamette River in Oregon, and the Mohawk River in New York. (Author's abstract)
W90-05300

OXYGEN AND TEMPERATURE RELATIONSHIPS IN NINE ARTIFICIALLY AERATED CALIFORNIA RESERVOIRS.
Hawaii Inst. of Marine Biology, Honolulu.
A. W. Fast, and R. G. Hulquist.
California Fish and Game CAGAX, Vol. 75, No. 4, p. 213-217, 1989. 3 fig, 1 tab, 6 ref.

Descriptors: *Lake restoration, *Reservoir operation, *Destratification, *Thermal stratification, *Aeration, *Water temperature, *Air, *Water quality control, *Oxygenation, *Mixing.

Artificial thermal destratification by air injection is a common reservoir management technique to eliminate anaerobic conditions near the reservoir's bottom, and thus creating additional fish habitat, and improving drinking water quality. Although artificial destratification usually results in the elimination of anaerobic conditions, the relationship between the degree of mixing and the resultant oxygen concentration of deep water has not been evaluated. In this study, thermal destratification and the ratio of air volume injected (Qa) to reservoir water volume (V) were positively correlated in nine southern California reservoirs. There was no correlation between either Qa/V and minimum oxygen concentrations in these reservoirs, nor between oxygen minima and thermal destratification. Although artificial aeration is regularly used to increase oxygen concentrations to a desired level, there are presently no quantitative procedures for sizing a destratification system to achieve the desired oxygen concentrations. Practitioners, with extensive experience with reservoir aeration systems and with adequate background information on a given reservoir, might be able to design an aeration system that will achieve a minimum dissolved oxygen concentration. Clearly, an objective, quantitative procedure is needed for designing aeration systems to meet minimum oxygen needs in reservoirs, especially for the average potential user. (Author's abstract)
W90-05323

WATER QUALITY DEVELOPMENT OF THE ARTIFICIAL LAKES LOKKA AND PORTTIPAHITA IN FINNISH LAPLAND.
Water and Environment District of Lapland, Rovaniemi (Finland).
K. Kinnunen.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p. 11-17, 1989. 6 fig, 1 tab, 3 ref.

Descriptors: *Reservoir operation, *Water level fluctuations, *Artificial lakes, *Water quality, *Dissolved solids, *Dissolved oxygen, *Lokka, *Porttipahta, *Finland, *Lapland.

The two biggest artificial lakes of Western Europe have been built at the upper part of the Kemijoki river basin. These artificial lakes, Lokka and Porttipahta, were constructed at the end of the 1960's for the water storage of the Kemijoki River hydropower production system. The surface areas of Lokka and Porttipahta, at the highest permitted regulation level, are 417 sq kilometers and 214 sq

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kilometers, respectively. The maximum permitted range of variation in the water level is 5 meters in Lokka and 11 meters in Porttipahta, but in practice, the ranges have been smaller. These artificial lakes are filled up mainly during spring flood and drawn down during the ice-covered period. The regulation is carried out on the basis of consecutive years. The water quality of the artificial lakes has been monitored since their construction. The late winter oxygen situation was worst in 1974 and 1977 when the regulation of the lakes was most extreme. Because of the lack of oxygen, there were local fish deaths in Lokka and a massive escape of fish to surrounding rivers. The concentration of organic matter was highest in both lakes in the middle of the 1970's. After about 12-15 years, both lakes reached a kind of steady state in water quality. The steady state will persist if the regulation remains consistent with recent practices. (Author's abstract)

W90-05344

TWO MANIPULATED INNER BAYS IN THE HELSINKI SEA AREA, NORTHERN GULF OF FINLAND.

Helsinki City Water and Wastewater Authority (Finland). Water Conservation Lab.
R. Varmo, H. Viljamaa, L. Pesonen, and I. Rinne. *Aqua Fennica AQFEDI*, Vol. 19, No. 1, p 67-73, 1989. 6 fig, 11 ref.

Descriptors: *Cleanup operations, *Water pollution effects, *Eutrophication, *Wastewater pollution, *Finland, Water quality, Monitoring, Dredging, Phosphorus removal.

Water quality has been poor in the inner bays of the Helsinki sea area because of the length of time that wastewater has been discharged there. However, as a result of improved municipal wastewater purification techniques and the reduction in phosphorus, some signs of recovery have been noted since the monitoring period started in 1965. This paper briefly reviews the results of monitoring in two manipulated inner bays. Despite these improvements, recovery has been slow and may be due to the effect the sediments have on the water layer. It is suggested that although dredging can help keep the bays deep, this practice may not benefit water or bottom quality. (Male-PTT)

W90-05346

PROPOSED TECHNICAL SLUDGE REGULATION UPDATE.

Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control. For primary bibliographic entry see Field 5E. W90-05348

DISSOLUTION OF CALCITE IN ACID WATERS: MASS TRANSPORT VERSUS SURFACE CONTROL.

Oxford Univ (England). Physical Chemistry Lab. R. G. Compton, K. L. Pritchard, and P. R. Unwin. *Freshwater Biology FWBLAB*, Vol. 22, No. 2, p 285-288, October 1989. 3 fig, 18 ref.

Descriptors: *Acid rain effects, *Acid lakes, *Lake restoration, *Liming, *Lime, *Acidic water, *Calcite, Hydrogen ion concentration, Earth-water interfaces.

A new experimental method for the study of kinetics and mechanism of reactions at the solid-liquid interface has shown that the dissolution of calcite in acidic waters is, under conditions of high mass transport, controlled by the first order heterogeneous reaction of H^+ at the interface and not by diffusion as previously thought. The implications of this for lake liming strategies (aimed at countering the effects of acid rain) are significant in that under typical liming conditions, the rate of calcite dissolution will be surface controlled and consequently appreciably slower than previously considered. (Author's abstract)

W90-05362

DEVELOPING A STATISTICAL SUPPORT SYSTEM FOR ENVIRONMENTAL HAZARD EVALUATION.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology. For primary bibliographic entry see Field 5C. W90-05369

EVALUATION OF ANTIFOULING PROPERTIES OF NON-TOXIC MARINE PAINTS.

Aix-Marseille-1 Univ. (France). Lab. de Chimie Macromoléculaire.

A. Mellouki, A. Bianchi, A. Perichaud, and G. Sauvet.

Marine Pollution Bulletin MPNBZ, Vol. 20, No. 12, p 612-615, December 1989. 4 fig, 1 tab, 12 ref.

Descriptors: *Water pollution prevention, *Antifoulants, *Biocides, *Path of pollutants, *Ammonium salts, Tin, Microbiological studies, Performance evaluation, Aquatic bacteria.

The anti-microfouling properties of some insolubilized quaternary ammonium salts (grafted onto a vinyl copolymer by means of a covalent non-hydrolyzable bond) were evaluated and compared with untreated, or tin-salt painted surfaces. The antifouling activity of the copolymers was tested in two forms: as a varnish film obtained by soaking polyvinyl chloride (PVC) sheets in a solution of copolymer in xylene or dichloromethane and air-drying (quaternary ammonium groups were 0.3 and 1.45 mol/kg of dry-extract); or as paints prepared by adding the copolymer to a mixture of xylene (18.9%), colophane (15.1%), iron oxide (4.9%), copper oxide (56.8%), suspension agent + plasticizer (4.3%) (concentrations of 0.06, 0.105, and 0.165 mol/kg of dry-extract). Experimental varnishes and paints as well as a commercial antifouling paint containing tributyltin oxide and an untreated control PVC sheet were immersed in a basin filled with seawater. Samples were collected after varying immersion times up to 4 months and levels of bacterial colonization were assessed by counting viable colonies and by scanning electron microscopy. Results showed that the microbial cover on the surfaces treated with ammonium salts or tin compounds was limited to bacterial forms, without microalgae or cyanobacteria as observed on the untreated surfaces. Bacteria were mostly of unicell form and, at the highest ammonium concentrations, numerous areas appeared free of any microorganisms. These findings show that quaternary ammonium salts chemically bonded to a polymer to avoid diffusion of toxic compounds in the marine environment can efficiently prevent microbiofouling of immersed surfaces. (Geiger-PTT)

W90-05407

COMPARATIVE AQUATIC ECOLOGY RESEARCH ON PHOSPHATE AND PHOSPHATE SUBSTITUTES FOR DETERGENTS (VERGLEICHENDE UNTERSUCHUNGEN ZUR BEWERTUNG VON PHOSPHAT UND PHOSPHATERSATZSTOFFEN AUS DER SICHT DER AQUATISCHEN ÖKOLOGIE).

Bayerische Landesanstalt fuer Wasserforschung, Wielenbach (Germany, F.R.).

A. Hamm.

Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 22, No. 6, p 257-262, December 1989. 4 fig, 2 tab, 9 ref. English summary.

Descriptors: *Water pollution prevention, *Phosphates, *Detergents, *Water pollution effects, *Ecological effects, Lakes, Ecosystems, Model studies, Phytoplankton, Macrophytes, Fish, Zooplankton, Benthos.

The 'Phosphates and Water' committee in the Water Chemistry Group of German Chemists has been assessing the effects of phosphate and phosphate substitutes in detergents for many years. Comparative investigations were conducted on the effect of detergents containing phosphates and phosphate substitutes on aquatic biocenosis through the use of model-ecosystems (natural ponds). Compounds studied included Zeolith A, one phosphonate compound, EDTA and NTA. The model ecosystems have been useful in quantifying the effects on phytoplankton, phytobenthos, macrophytes, zooplankton, zoobenthos and fish. The models were also useful in the quantification of the biologically influenced chemical parameters. (Geiger-PTT)

W90-05422

THERMAL REGIME OF LAKE DRUKSIAL.

Akademiya Nauk Litovskoi SSR, Vilnius. Inst. of Zoology and Parasitology.

For primary bibliographic entry see Field 2H. W90-05461

SIMULATED IMPACTS OF FLOW REGULATION ON BLUE-GREEN ALGAE IN A SHORT RETENTION TIME LAKE.

Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering. O. Varis.

Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 181-189, November 1989. 4 fig, 5 tab, 29 ref.

Descriptors: *Limnology, *Water quality control, *Cyanophyta, *Lakes, *Reservoirs, *Retention time, *Flow control, *Flood peak, *Water quality, Seasonal variation, Mathematical models, Lake Kuortaneenjärvi, Finland, Flood control, Water quality.

Many features, often mentioned as being characteristic of reservoirs, are relatively frequent within Finnish lakes. In the district of Southern Ostrobothnia, all the lakes have a short retention time, high water color value and strong seasonal variations in the flow regime. The impacts of flow regulation on algae, specially of the spring flood control, were studied in Lake Kuortaneenjärvi using whole lake simulation. The regulation period with greatest influences on blue-green algae was during the spring flood. However, attempting to combat N-fixing blue-greens by decreasing the outflow during the growing flood and increasing it after the flood peak was unsuccessful. The results suggest that cutting the flood peak using a lake or reservoir when there are problems with blue-green algae and in lakes with a relatively short retention time can cause deterioration of water quality. (Author's abstract)

W90-05469

PARTICULATE ORGANIC MATTER AND ITS ROLE IN THE FORMATION OF WATER QUALITY IN LAKE SEVAN (ARMENIA).

Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.

For primary bibliographic entry see Field 2H. W90-05479

MANAGEMENT OF RESERVOIR RELEASES: IMPROVING THE DOWNSTREAM ENVIRONMENT BY RESERVOIR RELEASE MODIFICATIONS.

Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.

For primary bibliographic entry see Field 8L. W90-05528

STREAMFLOW AND WATER-QUALITY DATA FOR LITTLE CLEARFIELD CREEK BASIN, CLEARFIELD COUNTY, PENNSYLVANIA, DECEMBER 1987-NOVEMBER 1988.

Geological Survey, Harrisburg, PA. Water Resources Div.

For primary bibliographic entry see Field 2E. W90-05552

PROGRAM PLAN: TESTING OF VACUUM EXTRACTION AND IN-SITU AIR STRIPPING TECHNOLOGIES.

Savannah River Lab., Aiken, SC. Technical Div. D. S. Kaback, and B. B. Looney.

Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016058. Price codes: A02 in paper copy, A01 in microfiche. Report No. DPST--87-561, July 24, 1987. 10p, 5 fig.

Descriptors: *Water pollution treatment, *Soil contamination, *Groundwater pollution, *Water

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5G—Water Quality Control

quality control, *Air stripping, *In situ treatment, Vacuum extraction, Costs, Boreholes, Vadose zone.

A remedial action program consisting of above-ground air stripping of groundwater is underway to address contamination in M Area at the Savannah River Plant (SRP). A recent pilot study to clean up the soils above the water table was completed in M Area using a new technique, in-situ vacuum extraction, which successfully removed significant quantities of trichloroethylene and tetrachloroethylene from the soils along a portion of the abandoned process-sewer line. The objectives of the plan are to: (1) develop a better understanding of gas flow in porous media during vacuum extraction; and (2) perform a field test that combines two new technologies: vacuum extraction and in-situ air stripping. Groundwater and the overlying soil in the vadose zone can then be remediated concurrently. Two vadose zone monitoring pressure lysimeter clusters will be constructed in a position lateral to the sewer line. These data will provide a three-dimensional view of the aquifer so that more can be learned about aquifer anisotropy. Two horizontal boreholes will then be drilled parallel to one another and parallel to the abandoned sewer line. The two horizontal boreholes will be offset approximately 150-ft, below the zone of highest organic concentrations in the groundwater. The shallow horizontal borehole will be located entirely within the vadose zone at a depth of approximately 80-ft. The two horizontal wells will be installed and developed in a manner that complies with safety, security, and housekeeping guidelines. The budget for the project is \$195,000. Installation of the horizontal wells is estimated at \$98,000; vacuum extraction, one soil core at the existing site, and installation of two pressure lysimeters is estimated at \$97,000. The schedule for the project is estimated at 28 weeks. Approximately one week is devoted to obtaining one soil core, installation of two pressure lysimeters, and vacuum-equipment setup. The initial tracer test will be run for a maximum of 4 weeks. The two horizontal boreholes will then be installed over a period of about 3 weeks. The remaining tests will be run over a period not to exceed 16 weeks. (Lantz-PTT)
W90-05582

PETROLEUM FATE AND CLEANUP AGENT TOXICOLOGY: AN ANNOTATED BIBLIOGRAPHY.

California Univ., Santa Cruz. Center for Marine Studies.
For primary bibliographic entry see Field 5B.
W90-05583

SUPERFUND RECORD OF DECISION: OLD BETHPAGE, NY.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134362. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/ROD/RO2-88/058, March 1988. 222p, 14 fig, 3 tab, 4 append.

Descriptors: *Superfund, *Cleanup operations, *Old Bethpage, *New York, *Water pollution treatment, *Leachates, *Methane, *Landfills, *Volatile organic compounds, Benzene, Trichloroethylene, Chromium, Inorganic compounds, Lead, Pollutant identification, Groundwater pollution.

The Old Bethpage landfill, covering approximately 65 acres, is located in Old Bethpage, Town of Oyster Bay, Nassau County, New York. Two public drinking water wells, a residential community, an industrial park, and a state park, exist within the site's general vicinity. Beginning in 1958, the Town of Oyster Bay operated the landfill as a municipal landfill. In addition to accepting municipal wastes and garbage, local industrial wastes were disposed of on the landfill during the late 1960s and early 1970s. The landfill ceased operations in April 1986. A system designed to collect, store, treat, and dispose of leachate has been operating at the site since 1983. There are three remedi-

al actions currently underway at the site. They include: leachate collection, methane gas collection, and landfill capping. The methane gas collection system was installed in phases in 1982 at the periphery of the site to monitor and prevent migration of gas beyond the property boundary. The 18-inch thick clay cap was applied to 29 acres of the landfill. The primary contaminants of concern affecting groundwater include: volatile organic compounds (VOCs), trichloroethylene, benzene, toluene, inorganics, chromium, and lead. Air is contaminated with methane gas and VOCs. The selected remedial action for this site includes: hydraulic control of the plume through installation of groundwater recovery wells; groundwater pump and treatment using air stripping and, if necessary, carbon filtration with discharge into an upgradient injection well system; groundwater monitoring; completion of the landfill capping (29 acres previously capped); continuation and expansion, or enhancement of the leachate control and gas collection systems; and gas monitoring. The estimated present worth cost of this remedial action is \$23,045,000. (Author's abstract)
W90-05584

STATUS OF US EPA'S SLUDGE INCINERATOR REGULATIONS.

Environmental Protection Agency, Washington, DC.
E. P. Crumpler, A. B. Rubin, and H. E. Bostian. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-124366. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/231, November 1988. 4p, 3 tab, 11 ref.

Descriptors: *Incineration, *Sludge treatment, *Regulations, *Wastewater treatment, *Air pollution, Pollution load, Dispersion, Standards.

A potential regulatory approach that the US EPA could use for controlling sewage sludge incinerators was developed. This approach utilizes a most exposed individual risk assessment to ensure that sludge incineration air emissions will not cause an unacceptable health risk. To expedite the permitting of facilities, the EPA has devised a three tier approach which will simplify the demonstration of compliance. The three tiers in essence define how the values of the dispersion factor (DF) and the pollutant control efficiencies (CE) are obtained. In Tier I, the owner/operator obtains credit for the height of his stack in determining the maximum allowable sludge concentration. For Tier I, the CE for each pollutant is taken from a table of reasonable worst case control efficiencies. These worst case control efficiencies were developed from a statistical analysis of a series of sludge incinerator tests. Thus, Tier I allows the calculation of reasonable worst case pollutant feed rates using only the reference air concentrations (RACs) specified by EPA, CE specified by EPA and the stack height at the facility. This approach will allow a significant number of US sludge incinerators to meet the new regulations with a minimum of effort and expense. An evaluation under Tier II is required if a facility can not demonstrate compliance under Tier I for all of the pollutants of concern. The Tier II assessment requires site specific air modeling to determine the value of DF and retains the reasonable worst case pollutant control efficiencies used in Tier I. If an evaluation under Tier II determines that one or more sludge pollutants fails the allowable pollutant feed rate (FR), then an evaluation under Tier III must be conducted. The Tier III assessment requires actual measurement of the control efficiency of the incinerator system by means of an emissions test. EPA is preparing guidance for the conducting of sludge incinerator tests. The guidance will specify sampling methods, sampling frequencies and test methods for the 17 pollutants. This guidance will be available prior to the final promulgation of the incinerator rules. Prior to the publication of the incinerator test guidance, any test plans for sludge incinerators prepared to comply with this regulation should be reviewed by the permitting official prior to the test. (Lantz-PTT)
W90-05590

WATER QUALITY AND RESTORATION OF THE LOWER OCONTO RIVER, OCONTO COUNTY, WISCONSIN.

Wisconsin Dept. of Natural Resources, Madison. R. A. Rost, J. C. Brand, R. M. Bruch, D. H. Crehore, and S. I. Dodson. Technical Bulletin No. 164, 1989. 36p, 12 fig, 25 tab, 25 ref, 2 append.

Descriptors: *Water pollution treatment, *Stream restoration, *Stream biota, *Water quality control, *Oconto River, *Water pollution control, *Aquatic environment, *Fish management, *Wisconsin, Fish populations, Management planning, Chemical treatment, Pulp wastes, Macroinvertebrates.

The purpose of the Oconto River Restoration Project (1979-83) was to develop and implement a plan to restore the water quality, aquatic environment, and fish habitat of the lower Oconto River in Oconto County, Wisconsin. This river segment had been severely degraded for over 70 years by pulp mill effluent. The lotic portions of the river improved as soon as the pulp mill closed in 1978. The Machickanee Flowage below the mill did not improve as rapidly, due to the accumulation of sediment polluted with heavy metals. Aquatic macrophytes, aquatic macroinvertebrates, and substrate suitable for fish spawning remained scarce. Beginning in 1979, data was collected on the following: water quality; sediment volume, elutriate, and compaction rates; zooplankton; aquatic macrophytes; aquatic macroinvertebrates; and fish populations and movement. Based on the data from 1979 and 1980, a management plan was designed for restoration of the area affected by discharge from the mill. The principal elements of the plan were: (1) an extended drawdown of the Machickanee Flowage to change the physical consistency of the accumulated sediment; (2) chemical treatment of fish populations in the Machickanee Flowage to eradicate rough fish; (3) fish stocking to establish game fish and panfish following the chemical treatment; (4) access development; (5) establishment of contingency funds for habitat improvement and additional fish stocking if necessary; (6) continuous monitoring for a 3-year period to determine the effectiveness of the management techniques applied; and (7) an intensive public relations program conducted throughout the project. The Machickanee Flowage was drawn down in May 1981 and in September 1981 the water remaining in the flowage basin was treated with rotenone to eliminate rough fish. The flowage basin was refilled following the treatment, and fish were stocked from 1981 through 1983. Because of the drawdown the character of the sediment changed such that both numbers and species of aquatic plants and aquatic macroinvertebrates greatly increased. The amount of suitable substrate for fish spawning also increased. A creel census and other surveys conducted after the management plan was implemented indicated that the aquatic ecosystem was more favorably balanced. (Lantz-PTT)
W90-05610

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.

Geological Survey, Reston, VA. Water Resources Div.
M. A. Hardy, P. P. Leahy, and W. M. Alley. Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-396, 1989. 36p, 2 fig, 9 tab, 28 ref.

Descriptors: *Sampling, *Network design, *Data acquisition, *Water quality, *Wells, *Groundwater quality, *Water sampling, Well construction, Standards, Drilling, Organic compounds, Inorganic compounds, Sample preparation.

Several pilot projects are being conducted as part of the National Water Quality Assessment (NAWQA) Program. The purpose of the pilot program is to test and refine concepts for a proposed full-scale program. Three of the pilot projects are specifically designed to assess ground-

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water. The purpose of this report is to describe the criteria that are being used in the NAWQA pilot projects for selecting and documenting wells, installing new wells, and sampling wells for different water quality constituents. Guidelines are presented for the selection of wells for sampling. Information needed to accurately document each well includes site characteristics related to the location of the well, land use near the well, and important well construction features. These guidelines ensure the consistency of the information collected and will provide comparable data for interpretive purposes. Guidelines for the installation of wells are presented and include procedures that need to be followed for preparations prior to drilling, the selection of the drilling technique and casing type, the grouting procedure, and the well-development technique. A major component of the protocols is related to water quality sampling. Tasks are identified that need to be completed prior to visiting the site for sampling. Guidelines are presented for purging the well prior to sampling, both in terms of the volume of water pumped and the chemical stability of field parameters. Guidelines are presented concerning sampler selection as related to both inorganic and organic constituents. Documentation needed to describe the measurements and observations related to sampling each well and treating and preserving the samples are also presented. Procedures are presented for the storage and shipping of water samples, equipment cleaning, and quality assurance. Quality assurance guidelines include the description of the general distribution of the various quality assurance samples (blanks, spikes, duplicates, and reference samples) that will be used in the pilot program. (Lantz-PTT)
W90-05618

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

RISK ASSESSMENT OF GROUNDWATER CONTAMINATION AND CURRENT APPLICATIONS IN THE DECISION-MAKING PROCESS.

United Technologies Corp., East Hartford, CT.
For primary bibliographic entry see Field 5A.
W90-04606

WETLANDS AND SUBSISTENCE-BASED ECONOMIES IN ALASKA, U.S.A.

Alaska Univ., Fairbanks. Dept. of Anthropology.
For primary bibliographic entry see Field 2L.
W90-04638

LOW-HEAD HYDRO: AN EXAMINATION OF AN ALTERNATIVE ENERGY SOURCE.

Idaho Water Resources Research Inst., Moscow.
J. S. Gladwell, and C. C. Warnick.
Idaho Water Resources Research Institute,
Moscow, Idaho. September, 1978. 205 p.

Descriptors: *Water resources development, *Hydroelectric power, *Energy sources, Conferences, Economic aspects, Dams, Turbines, Governmental interrelations, Environmental impact.

While nationally hydroelectric generation contributes only 15% of our electric energy, until very recently it had been the basis of the Northwest's energy resources. It has provided a clean, abundant, and ever-renewing source of power since the first small dams were installed before the turn of the century. However, public and private utilities have almost come to the end of the era when new high dams are either acceptable to the public or are worthwhile from a cost-benefit comparison. National public policy has excluded the possibility of much hydroelectric development in the region by opting to preserve some rivers in a wild, free flowing state. That combination of circumstances presents several options in providing additional electrical supplies for the region. The most widely discussed course, and in many ways the easiest route, is to continue supplementing hydroelectric

generation with power from new thermal plants, using either coal or nuclear fuels. However, low-head hydroelectric technology offers great advantages. Probably the greatest of these are its environmental acceptability, its flexibility, and its potential to keep electrical rates reasonable. For all these advantages, there are still a number of barriers standing in the way of utilizing low-head technology as an integral part of our energy future in Idaho and the region. Those restraints are both technical and institutional. The papers in this book were prepared for the seminar 'Low-Head Hydroelectric Technology—Problems and Opportunities of an Alternative Energy Source,' which was held at the University of Idaho on June 6 and 7, 1978. The papers are divided into five sections: (1) economics; (2) low-head turbines; (3) the governmental presence; (4) the environment; and (5) surveys of energy potential. (Lantz-PTT)
W90-05137

URBAN LAND POLICY: SELECTED ASPECTS OF EUROPEAN EXPERIENCE.

Department of Housing and Urban Development, Washington, DC. Office of International Affairs.
For primary bibliographic entry see Field 4C.
W90-05138

FINAL FEASIBILITY REPORT: CATTARAUGUS CREEK, NEW YORK.

Army Engineer District, Buffalo, NY.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A201 132. Price codes: A04 in paper copy, A01 in microfiche. Main Report, December 1987. 69p, 7 fig, 10 tab.

Descriptors: *Feasibility studies, *Water resources development, *Cattaraugus Creek, *New York, *Flood control, Water demand, Water resources, Economic aspects, Management planning, Hydroelectric power, Recreation facilities, Cost-benefit analysis, Social aspects.

Cattaraugus Creek is about 70 miles long and drains an area of about 558 sq mi of western New York, passing through the villages of Arcade, Gowanda, and Springville. The lower 15 miles of the creek also flows through the Cattaraugus Indian Reservation. The main tributaries of the creek include Clear Creek at Arcade, Elton Creek, Buttermilk Creek, Spring Brook, Spooner Creek, South Branch Cattaraugus Creek, and Clear Creek at Iroquois. The primary water resources need for which a solution was sought under this authority was to reduce flood damages within the Cattaraugus Creek Basin. In addition, for dam/reservoir plans that were developed, the addition of hydroelectric power generating facilities and recreation facilities were also considered to maximize the economic efficiency of the basic flood control plans. As possible solutions, nine preliminary alternatives, and 11 additional detailed alternatives, in addition to the no-action option, were formulated and assessed. These alternatives fell into two broad categories: structural and nonstructural local protection plans in areas where a high concentration of flood damages exist (Sunset Bay area and Arcade); and dam/reservoir plans at Springville. However, either the plans considered were not economically justified (i.e., benefit-to-cost ratios were < 1.0), or the plans were not socially acceptable. Therefore, the Selected Plan is the no-action plan. (Lantz-PTT)
W90-05140

RISK ASSESSMENT FOR GROUNDWATER CONTAMINATION.

Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
For primary bibliographic entry see Field 5G.
W90-05178

DEVELOPING AND MANAGING A COMPREHENSIVE RESERVOIR ANALYSIS MODEL.

Hydrologic Engineering Center, Davis, CA.
R. J. Hayes, B. S. Eichert, and M. B. Hurst.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A202 118. Price codes: A03 in paper copy, A01 in microfiche.

Technical Paper No. 123, November 1988. 13p, 4 fig, 13 ref.

Descriptors: *Model studies, *Computer programs, *Documentation, *Computer models, *Reservoir operation, Reservoirs, Training, Education, Water resources management, Maintenance.

Corps of Engineers projects are operated in a wide range of physical environments with numerous operational constraints. The Corps' Hydrologic Engineering Center (HEC) has developed a generalized simulation model capable of analyzing complex river-reservoir systems. Computer program 'HEC-5, Simulation of Flood Control and Conservation Systems', has evolved during the last 16 years (1972-1988) from a flood control only, single event reservoir simulation model to a generalized hydrologic and economic reservoir simulation model with capabilities for flood control, water supply, and hydropower analysis for multi-flood or period of record analysis. HEC-5 has developed in ways which the program's author could not have anticipated, reflecting both the changing requirements of the Corps of Engineers and the evolution of computer systems. As program code is revised and new capabilities are added to a large program such as HEC-5, the need arises for a systematic, trackable, software maintenance system. The primary tool that is being currently utilized for updating and maintaining the HEC-5 package of software is OPCODE's 'Historian Plus', which is available on the HEC Harris 1000 computer. The Historian program provides a systematic procedure for tracking program modifications; thus as its name implies, it provides a 'history' of the programs development. The HEC has always endeavored to provide suitable documentation and training for each of its major programs. Current HEC-5 documentation includes: a Users' Manual; a separate Input Description, which is updated once or twice each year to reflect program developments; and Training Documents for Water Supply and Hydropower applications. HEC staff members provide HEC-5 field application support to Corps of Engineers offices upon request. Usually HEC assistance is sought by offices for a number of reasons including those without the necessary in-house HEC-5 expertise or for those studies which require code modifications to extend or add new program capabilities. Program support in the form of hotline assistance for both engineering and programming assistance is available to the Corps of Engineers and other federal agencies. At-site training course, application assistance and program modifications are also provided to Corps offices. (Lantz-PTT)
W90-05182

DISCHARGER GROUPING FOR WATER QUALITY CONTROL.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-05300

BAYESIAN INFERENCE APPLIED TO REAL-TIME RESERVOIR OPERATIONS.

Proctor and Red Group, St. Catharines (Ontario). A. Armijos, J. R. Wright, and M. H. Houck.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 38-51, January/February 1990. 6 fig, 3 tab, 17 ref, 2 append.

Descriptors: *Expert systems, *Reservoir operation, *Water resources management, Model studies, Reservoir releases, Reservoir storage, Bayesian inferencing.

A significant amount of research during the past few years has focused on the application of expert systems technology to problems of water resources management. While these investigations have led to speculation as to the benefits of intelligent reasoning applied to real-time reservoir operation, working systems are nonexistent or in the preliminary stages of development and testing. This research presents a novel perspective on the use of knowledge-based inferencing techniques applied to

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real-time reservoir operation. The model developed integrates three separate analytical procedures: (1) a rules-based inferencing procedure is used that takes as input the data necessary to incorporate the logic of operating rules; (2) a Bayesian procedure is utilized that contains prior categorical information about past decisions, and provides the decision maker a judgment about the quality of the release recommendation; and (3) the response of the decision maker is recorded and used to update the prior information knowledge base. Rules are used to achieve a real-time simulation that is comparable to other rule-based systems reflecting expert operations as proposed in the literature. The Bayesian mechanism then provides a judgment about the quality of recommended releases based on prior information and present conditions. An additional feature of this system is its learning capabilities that can be used for further refinement of system recommendations. (Author's abstract)
W90-05301

COMMUNITY PARTICIPATION IN THE WATER SUPPLY SECTOR IN SRI LANKA.
Engineering-Science, Inc., Pasadena, CA.
R. M. Bradley, and H. I. Karunadasa.
Journal of the Royal Society of Health JRSJDS, Vol. 109, No. 4, p 131-135, 1989. 11 ref.

Descriptors: *Sri Lanka, *Public health, *Community development, *Water resources development, *Developing countries, Water management, Water use.

A community participation approach in the planning and implementation of water and sanitation projects in less developed countries is discussed, and a procedure for implementing this approach, currently being used in Sri Lanka is outlined. The basic procedure for implementing community participation in 5 communities in Sri Lanka involves seven stages. Each stage is defined and includes: basic investigations, community orientation and preparation for community orientation, community consultation, education and planning, developing the water supply/sanitation program with the community, health education, project implementation, and monitoring/evaluation. The procedure emphasizes commitment to health education using community members and the setting up of community-based formal management committees to plan, develop and monitor all aspects of project implementation. Dedicated institutional support from the national water supply agency and the Ministry of Health is recognized as an essential component through providing professional project facilitators and ensuring that the project development institutions are continually aware of the need to address community participation issues. The establishment of a specialized unit within the water supply agency to focus on community participation and water supply/sanitation/health linkages is a key institutional support mechanism. (Male-PTT)
W90-05375

PRACTICAL APPROACHES TO RIPARIAN RESOURCE MANAGEMENT: AN EDUCATIONAL WORKSHOP.
May 8-11, 1989, Billings, Montana. American Fisheries Society, Bethesda, MD. 1989. 193p. Edited by Robert E. Gresswell, Bruce A. Barton, Jeffrey L. Kershner.

Descriptors: *Land management, *Water resources management, *Water law, *Stream fisheries, *Riparian land, *Riparian vegetation, *Riparian waters, *Conferences, Management planning, Streams, Stream improvement, American Fisheries Society, Stream biota, Stream degradation, Stream stabilization, Streamflow, Urban watersheds, Monitoring.

In recent years the riparian zone has become an increasingly important resource consideration. However, literature describing riparian area management has been slow to develop. The American Fisheries Society confronted riparian resource management in an educational workshop held in May, 1989 in Billings, Montana. The primary purpose of the workshop was to bring together practical

and successful methodologies in riparian area management and promote and stimulate discussion among a wide variety of interests, such as technical specialists, resource planners, managers, and land owners. This collection of works from the conference includes 24 symposium papers. Topics range from selling management programs to data integration and collection; aspects of both urban and forest planning are discussed. Twenty-nine extended abstracts are also included in the book. Specific examples, management tactics and monitoring methods are presented. (See W90-05492 thru W90-05513) (Mertz-PTT)
W90-05491

SELLING A SUCCESSFUL RIPARIAN MANAGEMENT PROGRAM: A PUBLIC LAND MANAGER'S VIEWPOINT.
Bureau of Land Management, Prineville, OR. Prineville District Office.
For primary bibliographic entry see Field 4A.
W90-05492

OREGON WATERSHED IMPROVEMENT COALITION'S APPROACH TO RIPARIAN MANAGEMENT.
Oregon Watershed Improvement Coalition, Burns. Education Committee.
For primary bibliographic entry see Field 4A.
W90-05493

NEW APPROACH TO RIPARIAN MANAGEMENT IN WASHINGTON STATE.
Washington State Dept. of Fisheries, Olympia.
For primary bibliographic entry see Field 4A.
W90-05494

6B. Evaluation Process

PORT DEVELOPMENT IN THE U.S.: STATUS AND OUTLOOK.
Maritime Administration, Washington, DC. Office of Ports and Intermodal Development.
J. M. Pisani.
Oceanus OCEAAK, Vol. 32, No. 3, p 37-45, Fall 1989. 3 tab.

Descriptors: *Water resources development, *Water resources management, *Port facilities, *Ships, *Harbors, Foreign trade, Economic aspects, Financing, Trafficability.

The strategic and economic importance of the nation's ports is reviewed, as are current issues and future concerns involving the ports. With the present port system, development has been the responsibility of both the public and private sectors. However, the Water Resources Development Act of 1986 made significant changes in the roles, obligations, and opportunities of U.S. ports. This act altered the roles of federal, state, and local authorities in accomplishing harbor and waterway channel improvements and maintenance. The current status of deep-draft and shallow-draft ports is reviewed in terms of use, traffic, commerce movement, financing, and environmental, safety, and security issues. The American Association of Port Authorities has described five of the current major environmental challenges facing commercial ports as (1) public involvement in environmental law, (2) dredged material disposal, (3) contaminated sediments, (4) mitigation and wetlands preservation, and (5) reducing and relocating urban ports. Additional concerns include the safe and environmentally sound management of wastes generated by vessels and facilities in ports and the control of air pollution caused by marine vessels. The issue of container ships is addressed, as they are becoming larger and more complex, and are effecting immense problems on shoreline operating logistics. The need to improve bridge and tunnel clearances on main and port-access lines is an issue that inhibits the growth of double-stack operations. In the future, increased demand will be exerted on vessel and port terminal operators to become more productive, and hold down the costs of shipping the additional cargo brought about by the opening of new global ports and foreign trade. (Friedmann-PTT)

W90-04574

MULTICRITERION ANALYSIS OF HYDRO-POWER OPERATION.

Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
L. Duckstein, A. Teclé, H. P. Nachnebel, and B. F. Hobbs.
Journal of Energy Engineering (ASCE) JLEED9, Vol. 115, No. 3, p 132-153, December 1989. 5 fig, 7 tab, 33 ref. NSF grants INT 8620200, ECS-8802920, and ECE 85-52524.

Descriptors: *Water resources development, *Hydroelectric power, *Hydroelectric plants, *Decision making, *Ecological effects, *Social impact, Multicriterion analysis, Monte Carlo method, Austria, West Germany.

Two real-life examples show how multicriterion decision-making (MCDM) techniques can help hydropower engineers mitigate the environmental and social effects of hydropower development and operation. A brief introduction and overview of MCDM is presented, consisting of an 11-step process that starts with problem definition and ends with implementation. A typology of MCDM is provided, dividing the techniques into three groups: outranking, distance-based, and value-based or utility-based types. The operation of the Upper Isar River project in Bavaria is analyzed by means of a value technique and an outranking technique called multicriterion Q-analysis. Fourteen criteria are considered in that study, including power production, habitat quality for four groups of species, aesthetics, several recreation indices, minimum flows, and phosphorus loadings. The case study of the Erlauf River Division in Austria is evaluated using a distance-based technique called composite programming, combined with Monte Carlo simulation. An outcome of that study is that the facility's owners have increased the minimum instream flow in order to protect ecological values. (Author's abstract)
W90-04975

CONTENT ATTITUDE STUDY OF WATER RELATED TOPICS IN PUERTO RICO DAILY NEWSPAPERS.

Puerto Rico University, Mayaguez, Dept. of Social Sciences.
J. Gutierrez-Sanchez, and O. N. Hernandez.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119629/AS. Price codes: A03 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, June 1988. 28p, 3 fig, 8 tab, 12 ref, 2 append.

Descriptors: *Attitudes, *Behavior, *Public opinion, *Puerto Rico, *Social aspects, Administrative agencies, Local governments.

This content study of Puerto Rican newspaper identifies the principal water related issues printed in four newspapers as well as the format in which these issues appear. It also detects the manner in which newspapers profile agencies and functionalities associated with the water issues; it also presents a literature survey of Puerto Rican and classical content studies as well as of recent texts that discuss content analysis methodology. This study covers the period of July, 1986 through September, 1987. Relevant findings are: (1) the content issue most frequently mentioned was pollution followed by water rates. These findings reflect charges that the Aqueeduct and Sewer Authority (ASA) has not adequately managed or serviced water treatment plants and concern that water rates were increased 44% in 1986. (2) The governor of Puerto Rico was among the most frequently mentioned functionaries along with the Secretary of Health, a U.S. District Court Judge, the Secretary of the Treasurer, the regional director of the Environmental Protection Agency and the head of the Office of Consumer Affairs, DACO. (3) ASA has become an issue of public concern with the largest percentage of positive and negative mentions. A similar trend appears for the Department of Natural Resources. The least controversial

WATER RESOURCES PLANNING—Field 6

Water Law and Institutions—Group 6E

agency appears to be the U.S. District Court since it presents the largest percentage of neutral mentions. (4) There exist fragmentation of authority and funds among state agencies. This creates a lack of coordination to rationalize priorities; and (5) Water contamination is a problem in Puerto Rico due to inefficiency of waste treatment plants, fecal coliforms and the transmission of schistosomiasis. (USGS)
W90-05196

PLANNING AND ANALYSIS FOR WATER REUSE PROJECTS.
California State Water Resources Control Board, Sacramento.
For primary bibliographic entry see Field 3C.
W90-05289

RESOURCE ALLOCATION AND ENVIRONMENTAL OBJECTIVES. A REGIONAL EVALUATION OF SWEDISH EUTROPHICATION CONTROL POLICY 1965-80.
Linköping Univ. (Sweden). Dept. of Water in Environment and Society.
For primary bibliographic entry see Field 5G.
W90-05295

OPTIMIZATION OF VALUE OF CVP'S HYDROPOWER PRODUCTION.
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
J. A. Tejada-Guibert, J. R. Stedinger, and K. Staschus.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 52-70, January/February 1990. 5 fig., 3 tab., 29 ref., 2 append. NSF Grant CEE-8351819.

Descriptors: *Hydroelectric power, *California, *Hydroelectric power plants, *Energy conservation, *Model studies, Operating policies, Economic aspects.

CVPOP is a nonlinear programming model for the optimization of the multi-month operation of the hydropower system of the California Central Valley Project (CVP). CVPOP includes the dependence of energy values within each month on the capacity factor of the generating unit, avoiding the simplification of assuming constant monthly or yearly values as is common in other models. The model also includes contractual energy and capacity constraints which are nonlinear because of the powerplants' variable head performance curves (capability in MW and energy production rate in kWh per unit release versus reservoir storage). Results indicate that large problems stemming from complex configurations of water resource systems and from diverse physical, economic and operational conditions, often of an unequivocally nonlinear nature, may be solved with nonlinear programming techniques using currently available commercial systems. The staged solution process helped CVPOP converge to an optimal solution, overcoming the difficulties caused by nonconvexities in the constraints and the objective. The availability of good starting points from the revised CVPower program greatly aided convergence. The CVPOP model can be a valuable tool to investigate alternative CVP operation policies with respect to different energy value functions. The example presented shows that operation models should not ignore the variation in the value of energy from month-to-month and within a month if the maximum energy costs savings is to be achieved. (Author's abstract)
W90-05302

OPTIMIZING SPILLWAY CAPACITY WITH UNCERTAINTY IN FLOOD ESTIMATOR.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2E.
W90-05303

MITIGATION MEASURES RECOMMENDED IN CONNECTICUT TO PROTECT STREAM AND RIPARIAN RESOURCES FROM SUBURBAN DEVELOPMENT.

Connecticut Dept. of Environmental Protection, Marlborough. Bureau of Fisheries.
For primary bibliographic entry see Field 4C.
W90-05497

MANAGEMENT IMPLICATIONS FOR RIPARIAN DOMINANCE TYPES OF MONTANA.
Montana Univ., Missoula. School of Forestry.
S. W. Chadde, R. D. Pfister, and P. L. Hansen.
IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p. 83-85. 1 tab., 11 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Classification, *Plant populations, *Montana, *Stream biota, Riparian land, Stream classification, Vegetation, Ecology.

A classification of Montana's riparian plant communities, based on dominant species, was developed by the Montana Riparian Association. The dominance-type approach allows land managers to identify, inventory, and map riparian communities and provides basic management information for each type. As classifications based on site potential are developed, the dominance type approach will remain useful for describing existing conditions. For example, if dominance types have been documented (inventory or maps), they could be subdivided by riparian site types in order to recognize different environments. On the other hand, if riparian site types are documented, they could be subdivided by dominance types to illustrate major differences in current vegetation. One weakness of the dominance type classification is the broad and overlapping range of environments spanned by individual dominance types. However, the dominance type classification is only the first product in the development of a complete ecological classification of riparian vegetation and sites. (See also W90-05491) (Mertz-PTT)
W90-05504

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

WETLANDS AND SUBSISTENCE-BASED ECONOMIES IN ALASKA, U.S.A.
Alaska Univ., Fairbanks. Dept. of Anthropology.
For primary bibliographic entry see Field 2L.
W90-04638

6D. Water Demand

WATER CONSUMPTION PATTERNS AMONG INDIVIDUALS IN CAPE TOWN.
Cape Town Univ. (South Africa). Dept. of Community Health.
D. E. Bourne, and L. T. Bourne.
Water Science and Technology WSTED4, Vol. 21, No. 12, p. 1805-1808, 1989.

Descriptors: *Water use, *Municipal water, *Cape Town, *South Africa, Surveys, Drinking water, Beverages.

Liquid consumption patterns of about 1440 individuals were surveyed in Cape Town, South Africa in summer and winter. The survey asked for all food and drink items consumed in a 24-hour period. Total water consumption patterns were calculated by using food composition tables. Mean total water consumption was 1770 ml/person/day. Sources of water intake were as follows: tap water at home, 52%; tap water away from home, 10%; bound in food at home, 23%; bound in food away, 4%; in commercial products at home, 7%; in commercial products away, 3%. Solid foods were the source of 20.5% of total liquid intake. In solid foods, 68% of the water is in bound form, 18% is derived from domestic tap water, and 14% is from commercial products. (Cassar-PTT)
W90-04776

COMPILATION OF GEOHYDROLOGIC DATA COLLECTED AS PART OF THE AREAL AP-

PRAISAL OF GROUND-WATER RESOURCES NEAR BRANSON, MISSOURI.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05216

FRESHWATER WITHDRAWALS AND WATER-USE TRENDS IN FLORIDA, 1985.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. L. Marella.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. Florida Geological Survey State Map Report, 1989. 1 sheet, 1 tab., 7 fig., 11 ref.

Descriptors: *Water use, *Florida, *Maps, Withdrawals.

Total water withdrawn for use in Florida for 1985 was 17,057 million gallons/day (Mgal/d) (6,259 freshwater; 10,798 saline). Most freshwater withdrawn was groundwater (64%) and most saline water withdrawn was surface water (99%). Thermoelectric power generation accounted for more than 99% of saline-water withdrawals. Agricultural irrigation accounted for most freshwater withdrawals for both groundwater (41%) and surface water (60%). Freshwater withdrawals increased between 1975 and 1985 by almost 450 Mgal/d (excluding fresh surface water withdrawals for thermoelectric power generation). Groundwater accounted for 64% of Florida's total freshwater use in 1985, up from 51% in 1980 and 48% in 1975. Freshwater withdrawals increased between 1975 and 1985: public supply 44%, domestic self-supplied 28%, and agricultural irrigation 4%. Conversely, freshwater withdrawals for commercial-industrial self-supplied decreased 33% and thermoelectric power generation withdrawals used for cooling decreased 160% between 1975 and 1985. Florida ranked sixth in the Nation in groundwater withdrawals (about 4,000 Mgal/d) for 1985. Groundwater is the primary source of freshwater in Florida because it is readily available and is generally of good quality. The Floridan aquifer system supplied most (62%) of the groundwater in Florida in 1985. Fresh groundwater withdrawals increased 768 Mgal/d. Withdrawals of surface water declined between 1975 and 1985. Saline groundwater and treated wastewater have become important alternative water supplies. Withdrawals from saline groundwater for public supply accounted for about 17 Mgal/ and irrigation use from treated wastewater sources was about 51 Mgal/d in 1985. (USGS)
W90-05279

6E. Water Law and Institutions

EC DIRECTIVE ON DRINKING WATER (EEC 80/778).
Severn-Trent Water Authority (England).
For primary bibliographic entry see Field 5F.
W90-04902

DOWNTOWN COMMUNITY APPROVES A NEW WASTEWATER PLANT.
For primary bibliographic entry see Field 5D.
W90-04921

HOW CANADA CONTROLS GREAT LAKES POLLUTION.
For primary bibliographic entry see Field 5G.
W90-04927

URBAN LAND POLICY: SELECTED ASPECTS OF EUROPEAN EXPERIENCE.
Department of Housing and Urban Development, Washington, DC. Office of International Affairs.
For primary bibliographic entry see Field 4C.
W90-05138

Field 6—WATER RESOURCES PLANNING

Group 6E—Water Law and Institutions

ENVIRONMENTAL REGULATION: ITS IMPACT ON INFRASTRUCTURE DECISION MAKING.

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5G.
W90-05167

DISCIPLINARY AND INTERDISCIPLINARY ASPECTS OF GROUNDWATER QUALITY MANAGEMENT: A LAWYER'S PERSPECTIVE.

For primary bibliographic entry see Field 5G.
W90-05171

GROUNDWATER QUALITY MANAGEMENT: THE SEARCH FOR A LEGAL-INSTITUTIONAL FRAMEWORK.

For primary bibliographic entry see Field 5G.
W90-05173

EPA GROUND WATER PROTECTION STRATEGY.

Environmental Protection Agency, San Francisco, CA. Region IX.
For primary bibliographic entry see Field 5G.
W90-05175

LOCAL GOVERNMENT AND GROUNDWATER QUALITY MANAGEMENT.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W90-05176

NATIONAL POLICY FOR GROUNDWATER PROTECTION: DOES ONE EXIST?

Virginia Water Resources Research Center, Blacksburg.
For primary bibliographic entry see Field 5G.
W90-05177

ECONOMIC AND LEGAL ANALYSIS OF STRATEGIES FOR MANAGING AGRICULTURAL POLLUTION OF GROUNDWATER.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W90-05233

COMMUNITY PARTICIPATION IN THE WATER SUPPLY SECTOR IN SRI LANKA.

Engineering-Science, Inc., Pasadena, CA.
For primary bibliographic entry see Field 6A.
W90-05375

PRACTICAL APPROACHES TO RIPARIAN RESOURCE MANAGEMENT: AN EDUCATIONAL WORKSHOP.

For primary bibliographic entry see Field 6A.
W90-05491

NEW APPROACH TO RIPARIAN MANAGEMENT IN WASHINGTON STATE.

Washington State Dept. of Fisheries, Olympia.
For primary bibliographic entry see Field 4A.
W90-05494

FOREST PRACTICES AND RIPARIAN MANAGEMENT IN WASHINGTON STATE: DATA BASED REGULATION DEVELOPMENT.

Weyerhaeuser Co., Centralia, WA. Western Forestry Research Center.
R. E. Bilby, and L. J. Wasserman.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 87-94. 8 fig. 2 tab. 11 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Riparian land, *Washington, *Watershed protection, *Legal aspects, *Water law, *Riparian rights, *Forest management, *Environmental protection, *Environmental

policy, *Timber Fish and Wildlife Agreement, Forest watersheds, Logging, Wildlife, Management planning, Stream improvement.

In the past, forest practice regulations for riparian zones in Washington have been based primarily on political, rather than scientific, considerations. In 1986 a new process, called Timber, Fish and Wildlife, attempted to formulate regulations based on technical data. Separate regulations were devised for eastern and western Washington due to the differences between the two regions in vegetation, climate, and timber management strategies. In western Washington, where clear-cutting is the predominant harvest method, regulations were based on existing data on large organic debris loading in channels coupled with simulation models of stand dynamics. The regulations were designed to provide for the maintenance of large organic debris at the levels observed in streams in old-growth timber. Data for eastern Washington riparian zones were collected specifically for the purpose of designing new regulations. Uneven-aged management is the most common silvicultural technique practiced in this area. Information was collected on riparian stand characteristics and large organic debris size and frequency in streams. Regulations were designed to maintain large organic debris levels observed in unmanaged stands and were based on a relationship between stand density and large organic debris frequency. Wildlife needs were addressed by providing sufficient numbers of larger trees to generate snags, provide desired levels of canopy cover and maintain a multi-storied canopy. (See also W90-05491) (Author's abstract)
W90-05505

6F. Nonstructural Alternatives

DEVELOPING RAINFALL INSURANCE RATES FOR THE CONTIGUOUS UNITED STATES.

For primary bibliographic entry see Field 2B.
W90-04604

FINAL FEASIBILITY REPORT: CATTARAUGUS CREEK, NEW YORK.

Army Engineer District, Buffalo, NY.
For primary bibliographic entry see Field 6A.
W90-05140

REVIEW OF THE U.S. ARMY CORPS OF ENGINEERS INVOLVEMENT WITH ALLUVIAL FAN FLOODING PROBLEMS.

Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 2E.
W90-05186

6G. Ecologic Impact Of Water Development

PLAYA LAKES: PRAIRIE WETLANDS OF THE SOUTHERN HIGH PLAINS.

North Carolina Univ. at Wilmington.
For primary bibliographic entry see Field 2H.
W90-04555

DEAD SEA SURFACE-LEVEL CHANGES.

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2H.
W90-04559

PORT DEVELOPMENT IN THE U.S.: STATUS AND OUTLOOK.

Maritime Administration, Washington, DC. Office of Ports and Intermodal Development.
For primary bibliographic entry see Field 6B.
W90-04574

TEMPERATURE CHARACTERISTICS OF AN IMPOUNDED RIVER.

Rhodes Univ., Grahamstown (South Africa). Inst.

of Freshwater Studies.

For primary bibliographic entry see Field 4A.
W90-04631

TROPICAL DEFORESTATION TRIGGERS ECOLOGICAL CHAIN REACTION.

Water Environment and Technology, Alexandria, Virginia.

For primary bibliographic entry see Field 4C.
W90-04881

WATERWEED INVASIONS.

Toronto Univ. (Ontario). Dept. of Botany.
For primary bibliographic entry see Field 4A.
W90-04920

CLASSIFICATION OF WATER BEETLE ASSEMBLAGES IN ARABLE FENLAND AND RANKING OF SITES IN RELATION TO CONSERVATION VALUE.

West of Scotland Agricultural Coll., Auchincruive. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2H.
W90-04946

MULTICRITERION ANALYSIS OF HYDRO-POWER OPERATION.

Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
For primary bibliographic entry see Field 6B.
W90-04975

WATER QUALITY CHANGES CAUSED BY EXTENSION OF THE WINTER NAVIGATION SEASON ON THE DETROIT-ST. CLAIR RIVER SYSTEM.

Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5G.
W90-05146

WATER RESOURCES AND ESTIMATED EFFECTS OF GROUNDWATER DEVELOPMENT, CECIL COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2E.
W90-05208

WATER QUALITY DEVELOPMENT OF THE ARTIFICIAL LAKES LOKKA AND PORTTIPAHJA IN FINNISH LAPLAND.

Water and Environment District of Lapland, Rovaniemi (Finland).
For primary bibliographic entry see Field 5G.
W90-05344

PLANKTON COMMUNITY RESPONSE TO REDUCTION OF PLANKTIVOROUS FISH POPULATIONS: A REVIEW OF 11 CASE STUDIES.

Oslo Univ. (Norway). Biologisk Inst. A. Lyche.
Aqua Fennica AQFEDI, Vol. 19, No. 1, p 59-66, 1989. 1 tab, 57 ref. Norwegian Council for Scientific and Industrial Research (NTNF).

Descriptors: *Plankton, *Algal growth, *Lake restoration, *Limnology, Species composition, Fish populations, Ecological distribution, Oligotrophic lakes, Hypertrophic lakes, Nutrients.

The response of plankton communities to reductions in planktivorous fish are summarized and possible 'top-down' and 'bottom-up' related mechanisms governing the observed response are discussed in this review of whole-lake studies. In the majority of the selected lakes, the phytoplankton biomass decreased; cyanobacteria relative abundance decreased; gelatinous chlorophytes, cryptomonads and/or chrysomonads increased; algal diversity increased; zooplankton biomass increased or was unchanged; and Daphnia sp. increased in individual size and relative abundance. Diverging response occurred in one oligotrophic lake, where

Eudiaptomus and Ceratium became dominant; in one eutrophic lake, where algal biomass was unchanged; and two hypertrophic lakes where algal biomass increased and cyanobacteria increased in colony size and relative abundance. Reduction of algal biomass is related to increased grazing on a larger size range of phytoplankton, and probably also to increased specific growth rate of the remaining algae, which decreases their carbon to phosphorus-ratio. Algal biomass-reduction is probably also governed by changes in the nutrient supply by decreased internal phosphorus-loading by fish and increased phosphorus-sedimentation by zooplankton. Changes in phytoplankton species composition is related to increased specific nutrient supply, favoring small algae that compensate for grazing loss by growing faster. These changes are probably also influenced by increased light penetration, increased N:P-ratios, decreased iron chelation by fish mucus, as well as by changes in the mode of nutrient supply, all disfavoring cyanobacteria. Zooplankton biomass increase relates to decreased vertebrate predation, as well as to the increased edibility and improved nutritional quality of the phytoplankton. Changes in zooplankton species composition involves reduced size-selective predation on large species, increased invertebrate predation on smaller zooplankters, as well as the competitive superiority of Daphnia. Diverging response is related to very low specific nutrient supply (the oligotrophic lake), or to very high and increasing phosphorus-concentration (hypertrophic lakes), approaching nitrogen-limitation in the phytoplankton. (Author's abstract)

W90-05345

ENERGY FROM THE AMAZON.

For primary bibliographic entry see Field 8C.
W90-05350

CANOCO—AN EXTENSION OF DECORANA TO ANALYZE SPECIES-ENVIRONMENT RELATIONSHIPS.

Instituut TNO voor Wiskunde, Informatieverwerking en Statistiek, Wageningen (Netherlands). Agricultural Mathematics Group.
For primary bibliographic entry see Field 5C.
W90-05370

FISHERY IN NATURE RESERVES (FISCHEREI IN NATURSCHUTZGEBIETEN).

Landesamt fuer Wasserwirtschaft Rheinland-Pfalz, Mainz (Germany, F.R.).
For primary bibliographic entry see Field 8I.
W90-05417

FISHES OF NORTH AMERICA ENDANGERED, THREATENED, OR OF SPECIAL CONCERN: 1989.

Bureau of Land Management, Washington, DC. Endangered Species Committee.
For primary bibliographic entry see Field 8I.
W90-05448

EXTINCTIONS OF NORTH AMERICAN FISHES DURING THE PAST CENTURY.

Michigan Univ., Ann Arbor. Museum of Zoology.
For primary bibliographic entry see Field 8I.
W90-05449

RESPONSE OF JUVENILE STEELHEAD TO INSTREAM DEFLECTORS IN A HIGH GRADIENT STREAM.

Humboldt State Univ., Arcata, CA. Dept. of Fisheries.
For primary bibliographic entry see Field 8I.
W90-05513

FISHERY MANAGEMENT IN COOLING IMPOUNDMENTS.

Duke Power Co., Huntersville, NC. Production Environmental Services.
For primary bibliographic entry see Field 8I.
W90-05523

OVERVIEW OF RESERVOIR FISHERIES PROBLEMS AND OPPORTUNITIES RESULTING FROM HYDROPOWER.

Sport Fishing Inst., Washington, DC.
For primary bibliographic entry see Field 8I.
W90-05524

FISHERIES PROBLEMS ASSOCIATED WITH THE TRUMAN DAM PUMPED STORAGE HYDROELECTRIC PROJECT IN WEST CENTRAL MISSOURI.

Missouri Dept. of Conservation, Columbia.
For primary bibliographic entry see Field 8I.
W90-05525

MANAGEMENT OF LARGEMOUTH BASS IN A PERCHED COOLING POND IN ILLINOIS.

Illinois Power Co., Clinton. Clinton Power Station.
For primary bibliographic entry see Field 8I.
W90-05526

WALLEYE MIGRATION THROUGH TYGART DAM AND ANGLER UTILIZATION OF THE RESULTING TAILWATER AND LAKE FISHERIES.

West Virginia Dept. of Natural Resources, Fairmont. Div. of Wildlife Resources.
For primary bibliographic entry see Field 8I.
W90-05531

LARVAL FISH AND SHELLFISH TRANSPORT THROUGH INLETS.

For primary bibliographic entry see Field 8I.
W90-05532

ECOLOGY OF THE LOWER COLORADO RIVER FROM DAVIS DAM TO THE MEXICO-UNITED STATES INTERNATIONAL BOUNDARY: A COMMUNITY PROFILE.

Arizona State Univ., Tempe. Center for Environmental Studies.
R. D. Ohmart, B. W. Anderson, and W. C. Hunter. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-130355. Price codes: A14 in paper copy, A01 in microfiche. Biological Report 85(7.19), September 1988. 296p, 42 fig, 61 tab, 255 ref, 2 append.

Descriptors: *Land use, *Environmental effects, *Ecology, *Colorado River, *Water resources development, *Ecological effects, Mexico, Davis Dam, Riparian waters, Ecosystems, Wildlife, Riparian vegetation, Water quality trends.

This report reviews and synthesizes ecological information on the Lower Colorado River from the Davis Dam to the Mexico-United States border. It describes past and present environmental conditions in the River and on adjacent riparian lands along the River. The River and adjacent floodplains have been greatly changed, generally to the detriment of native flora and fauna. Native riparian woodlands have decreased dramatically as a result of agricultural conversion, and the most common species of tree along the River is now exotic saltcedar. Native wildlife populations have been seriously impacted by these land use and habitat changes. Native fisheries have been similarly impacted by changes in the flow and quality of water in the River resulting from upstream impoundments, diversion, and irrigation return flows. Opportunities exist for reversing these trends through alteration in the management of the River; however, it will require changes in the way political, social, and economic decisions are made in this region. (Author's abstract)

W90-05616

7. RESOURCES DATA

7A. Network Design

INSTRUMENTATION FOR ESTUARINE RESEARCH.

Washington Univ., Seattle. School of Oceanogra-

phy.

R. W. Sternberg.

Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,289-14,301, October 15 1989. 28 fig, 2 tab, 23 ref. NSF grant OCE85-08939.

Descriptors: *Estuaries, *Sediment transport, *Instrumentation, *Sediment distribution, *Sampling, *Sedimentation, Marine sediments, Monitoring, Estuarine environment, Advection, Deposition.

Estuaries are large bodies of water within which complex interactions of physical, chemical, and biological processes with suspended and bottom sediments occur. The goals of estuarine sediment transport research are broad and place diverse requirements on instruments and methods of observation. Processes of sediment advection often are investigated with methods that provide synoptic observations over expanded geographical regions, i.e., remote sensing and rapid shipboard reconnaissance techniques. In contrast, time series data collected within an estuary by anchored ships or by moored or semipermanently emplaced instruments are used for the study of the processes or mechanics of sediment resuspension and deposition. Understanding the mechanics of estuarine sediment transport also provides important insights into the regional or advective processes active in estuaries. The present status of methods used for estuarine sediment transport research, as well as some important methods under development, as well as the various classes of instruments designed to meet the measurement requirements, are reviewed for (1) Boundary layer flows and suspended sediment response; (2) Threshold of grain motion; (3) In situ particle characteristics; (4) Particle size; and (5) Settling velocity. (Author's abstract)

W90-04560

COST EFFECTIVENESS OF BENTHIC FAUNAL MONITORING.

P. F. Kingston, and M. J. Kiddle. Marine Pollution Bulletin MPNBZ, Vol. 20, No. 10, p 490-496, October 1989. 12 fig, 1 tab, 16 ref.

Descriptors: *Sampling, *Data acquisition, *Oil pollution, *Monitoring, *Biological samples, Environmental protection, Benthos, Bottom sampling, Water pollution, Water quality control, Cores, Sampling techniques.

Recent amendments to the Prevention of Oil Pollution Act have set minimum standards for environmental monitoring associated with the offshore oil industry. Many oil companies include extensive biological surveys in their monitoring programs. Offshore environmental monitoring is a costly escape from every aspect. It is difficult to escape the inference that single 0.1 square meter samples are capable of detecting effects of pollution just as well as multiple samples and that the present approach to benthic monitoring is wasteful of both time and resources. Such an approach does not take into account the intrinsic heterogeneity of the benthos and the increased likelihood of particularly erratic faunal distributions around an installation. The major attractions of the single 0.1 square meter grab sample is the low cost of analysis. If a similar total surface area were sampled using a number of cores (e.g. 20 x 8 cm diameter), the total volume requiring analysis would remain the same, but there would be a considerable increase in the amount of information obtained. Multiple core samples would overcome the disadvantages of a single large grab by allowing a measure of variability and would remove the risk of aberrant patches unduly influencing the results. Typical costings for offshore benthic faunal surveys show that for a 10 station survey, replacing 5 replicate grab samples with 20 cores per site would produce analytical cost savings that would permit up to 3 days additional ship time at current prices. For inshore monitoring, cost saving would permit up to 3 days additional ship time at current prices. For inshore monitoring, cost savings would be even greater, because a smaller survey vessel is needed and analytical costs are greater. In shallow locations, coring could be efficiently and relatively cheaply carried out by divers. Offshore sampling presents

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more problems as there are no devices currently in production that will take multiple core samples. Most of the requirements for such an offshore sampler could be met by a multiple corer consisting of self-powered core units capable of individual operation from the surface. The addition of an underwater television camera to the unit would enable the operator to choose the areas to be sampled where there is obvious patchiness of the seabed. (Mertz-PTT)
W90-04964

DDT IN MYTILUS EDULIS: STATISTICAL CONSIDERATIONS AND INHERENT VARIABILITY.

Universidad Autonoma de Baja California (Mexico). Inst. de Investigaciones Oceanograficas. For primary bibliographic entry see Field 5A.
W90-04965

MONITORING OF TIME TRENDS IN CONTAMINANT LEVELS USING A MULTISPECIES APPROACH: CONTAMINANT TRENDS IN ATLANTIC COD (GADUS MORHUA) AND EUROPEAN FLOUNDER (PLATICHTHYS FLESUS) ON THE BELGIAN COAST, 1978-1985.
Delaware Univ., Newark. Coll. of Marine Studies. For primary bibliographic entry see Field 5A.
W90-04966

TREND MONITORING OF DISSOLVED TRACE METALS IN COASTAL SEA WATER: A WASTE OF EFFORT.
Marine Lab., Aberdeen (Scotland). For primary bibliographic entry see Field 5B.
W90-04982

ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY'S HYDROLOGIC INSTRUMENTATION FACILITY IN SUPPORT OF HAZARDOUS-AND TOXIC-SUBSTANCES PROGRAMS.
U.S. Geological Survey, Stennis Space Center, Mississippi. For primary bibliographic entry see Field 7B.
W90-05127

STATUS REPORT ON A STUDY OF THE EFFECTS OF ACID MINE DRAINAGE ON VEGETATION NEAR LEADVILLE, COLORADO.
Geological Survey, Denver, CO. For primary bibliographic entry see Field 5C.
W90-05128

PROCEDURE FOR EVALUATING OBSERVATION-WELL NETWORKS IN WYOMING, AND APPLICATION TO NORTHEASTERN WYOMING, 1986.
Geological Survey, Cheyenne, WY. Water Resources Div. J. C. Wallace, and M. A. Crist. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4215, 1989. 29p, 17 fig, 21 ref.

Descriptors: *Observation wells, *Network design, *Water level, *Powder River Basin, *Monitoring, *Geohydrologic units, Well data, Aquifers, Groundwater withdrawals, Wyoming.

A sequence of steps was developed for evaluating and modifying the existing, long-term, observation-well network in any part of Wyoming. The State was subdivided geographically into nine groundwater areas, including the northeastern Wyoming groundwater area, based on major structural features. Northeastern Wyoming was the first of the nine areas to be evaluated using these procedures. The stratigraphic units of Wyoming were grouped into five rock units on the basis of age, similar depositional environments, and water-yielding properties. Activities likely to affect groundwater in northeastern Wyoming were evaluated. The most important monitoring needs in the area are related to: (1) Oil-field waterflooding; (2) surface mining of coal; (3) increasing municipal use of groundwater, and (4) need for general resource

information. The 18 observation wells in the existing (1986) network meet most of the needs identified. Seven additional wells need to be added to the network, whereas four wells in the network can be discontinued. Water level data from the 18 observation wells are presented by county. Maps and hydrographs are accompanied by brief discussions of information related to the records obtained. (USGS)
W90-05276

HYDROMETRIC NETWORK EVALUATION: AUDIT APPROACH.

Inland Waters Directorate, Dartmouth (Nova Scotia). Z. K. Davar, and W. A. Brimley. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 134-146, January/February 1990. 2 fig, 2 tab, 18 ref.

Descriptors: *Network design, *Data acquisition, *Canada, *Water resources management, *Hydrometric networks, Resource allocation, Monitoring, Streamflow, Standards, Economic aspects, Water users.

An evaluation of the hydrometric network of New Brunswick was performed starting from basic principles of hydrometric network design and proceeding through the analysis of the present network and its ability to meet user needs. Discharge stations used to monitor the streamflow component of the regional hydrology are assessed on their ability to contribute to the transfer of information to ungaged sites. A survey was conducted to determine users' needs. The results of the various analyses are combined using an audit approach based on selected rating factors. The final output includes specific network improvements designed to satisfy hydrometric needs. These improvements are presented in the form of a list of network adjustment scenarios that are available as a management guide. This methodology overcomes the historical tendency to simply augment the network in response to incremental needs. In addition, the methodology is flexible, in that objectives can be modified and assumptions revised based on management priorities, and the results can be readily identified. The overall objective is to create a rationalized and more cost-effective network. (Author's abstract)
W90-05306

DEVELOPING A STATISTICAL SUPPORT SYSTEM FOR ENVIRONMENTAL HAZARD EVALUATION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology. For primary bibliographic entry see Field 5C.
W90-05369

CANOCO—AN EXTENSION OF DECORANA TO ANALYZE SPECIES-ENVIRONMENT RELATIONSHIPS.

Instituut TNO voor Wiskunde, Informatieverwerking en Statistiek, Wageningen (Netherlands). Agricultural Mathematics Group. For primary bibliographic entry see Field 5C.
W90-05370

MINIMAL SAMPLING SCHEDULE FOR A DYNAMIC LAKE MODEL.

Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering. J. Ketunen. Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p. 193-200, November 1989. 3 fig, 2 tab, 15 ref.

Descriptors: *Limnology, *Sampling schedule, *Lakes, *Algae, *Water sampling, *Mathematical models, Growth, Respiration, Nitrogen, Phosphorus, Lake Kuortaneenjari, Finland, Water quality, Biological samplers, Model studies.

The design of a minimal sampling schedule in lake water quality research was studied. Model oriented experimental design theory was used to work out a measurement program for the estimation of specif-

ic growth and respiration rate parameters of algae in Lake Kuortaneenjari, southern Finland. The design was based on a dynamic lake model. Optimal timing of algal counts and simultaneous measurements of inorganic nitrogen and phosphorus were considered. The analysis was carried out using the historical data of one year. Six intensively studied 10 day periods offered the essential information for the estimation of six parameters of the model. The study revealed that the analysis of the system output does not necessarily give adequate information for the sampling design. Focusing attention on the time propagation of the system parameter sensitivity will lead to more realistic solutions. This is due to several interactive forces of the system. The use of experimental design methods helps to reduce non-relevant processes of the system behavior and thus permits better incorporation of goals in the sampling program. (Author's abstract)
W90-05470

SAMPLING OPTIMIZATION FOR STUDIES OF TIDAL TRANSPORT IN ESTUARIES.

South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research. For primary bibliographic entry see Field 2L.
W90-05536

PROCEDURE FOR EVALUATING OBSERVATION-WELL NETWORKS IN WYOMING, AND APPLICATION TO NORTHEASTERN WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div. J. C. Wallace, and M. A. Crist. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4215, 1989. 29p, 17 fig, 21 ref.

Descriptors: *Networks, *Network design, *Observation wells, *Wyoming, *Data acquisition, Wells, Monitoring, Groundwater budget, Water level, Geohydrology.

A logical sequence of steps was developed for evaluating and modifying the existing, long-term, observation-well network in any part of Wyoming. Monitoring water levels was emphasized, although monitoring water quality changes also was considered. The State was subdivided geographically into nine groundwater areas, including the northeastern Wyoming groundwater area, based on major structural features. Northeastern Wyoming was the first of the nine areas to be evaluated using these procedures. The stratigraphic units of Wyoming were grouped into five rock units based on age, similarity of depositional environments, and water yielding properties. These units, from oldest to youngest, are: (1) Paleozoic rock unit, (2) lower Mesozoic rock unit, (3) upper Mesozoic rock unit, (4) Tertiary rock unit, and (5) Quaternary rock unit. On the basis of an evaluation of activities likely to affect groundwater in northeastern Wyoming, the most important monitoring needs in the area are related to: (1) oil-field waterflooding, (2) surface mining of coal, (3) increasing municipal use of groundwater, and (4) need for general resource information. The 18 observation wells in the existing (1986) network meet most of these needs identified. Water level data from the 18 observation wells in northeastern Wyoming are presented in a format somewhat different from that used in previous data reports for Wyoming. For each county, hydrographs of water levels are arranged adjacent to a map showing the location of the wells. An accompanying narrative includes discussion of changes in water levels, water quality, changes in water use, possible changes in hydrologic conditions, or other information pertinent to the records obtained. As of 1986, substantial water level declines were recorded in one well completed in the Fort Union Formation of Paleocene age near Gillette, in one well completed in the Lance Formation and Fox Hills Sandstone of Late Cretaceous age near Gillette, and in one well completed in the Lakota Formation of Early Cretaceous age in northern Niobrara County. Substantial water level rises were recorded in one well completed in the

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Wasatch Formation of Eocene age at Gillette and in one well completed in the Madison Limestone of Mississippian age in northern Niobrara County. (Author's abstract)
W90-05597

7B. Data Acquisition

INSTRUMENTATION FOR ESTUARINE RESEARCH.
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 7A.
W90-04560

TRANSPORT PROCESSES OF SUSPENDED MATTER DERIVED FROM TIME SERIES IN A TIDAL ESTUARY.
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tespehude (Germany, F.R.)
For primary bibliographic entry see Field 2J.
W90-04567

STATISTICAL DISTRIBUTION OF DAILY RAINFALL AND ITS ASSOCIATION WITH THE COEFFICIENT OF VARIATION OF RAINFALL SERIES.
Indian Inst. of Tropical Meteorology, Poona.
For primary bibliographic entry see Field 2B.
W90-04595

DIURNAL VARIATIONS DURING THE AUSTRALIAN MONSOON EXPERIMENT (AMEX) PHASE II.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
For primary bibliographic entry see Field 2B.
W90-04610

AUSTRALIAN SUMMER MONSOON CIRCULATION DURING AMEX PHASE II.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
For primary bibliographic entry see Field 2B.
W90-04611

CLASSIFYING SOILS FOR ACIDIC DEPOSITION AQUATIC EFFECTS: A SCHEME FOR THE NORTHEAST USA.
Corvallis Environmental Research Lab., OR.
For primary bibliographic entry see Field 5B.
W90-04622

DIFFUSION METHODS FOR THE DETERMINATION OF REDUCED INORGANIC SULFUR SPECIES IN SEDIMENTS.
Florida Agricultural and Mechanical Univ., Tallahassee. Div. of Agricultural Science.
Y. P. Hsieh, and C. H. Yang.
Limnology and Oceanography LIOCAH, Vol. 34, No. 6, p 1126-1130, September 1989. 4 tab, 13 ref.

Descriptors: *Water analysis, *Tidal marshes, *Bottom sediments, *Sulfur, *Sulfides, *Chemical analysis, Diffusion methods, Salt marshes, Marsh plants.

Diffusion procedures for the separation of acid-volatile sulfide (AVS), Cr(II)-reducible sulfur (CRS), and elemental sulfur (ES) were developed to replace the conventional active distillation procedures. In these new procedures, reduced inorganic sulfur species are converted to hydrogen sulfide in a closed container at ambient temperature, and the hydrogen sulfide is allowed to diffuse into an alkaline zinc trap which subsequently can be retrieved and analyzed. The advantages of the diffusion methods are suitability for a large number of samples, specificity of the CRS diffusion procedure to pyrite-S after AVS removal, and capability to determine ES without prior extraction. Percent recovery of the added ferrous monosulfide, pyrite, and ES by the diffusion methods is comparable to those of active distillation. The diffusion methods were tested on the sediments of a Juncus roemer-

ianus tidal marsh in Florida. The pyrite content of the Juncus marsh was only 20-30% of the pyrite content found in a New England Spartina marsh studied previously, iron source in this limestone-derived sediment. (Author's abstract)
W90-04654

SEDIMENT TOXICITY ASSESSMENT USING BACTERIAL BIOLUMINESCENCE: EFFECT OF AN UNUSUAL PHYTOPLANKTON BLOOM.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
N. Bihari, M. Najdek, R. Floris, R. Batel, and R. K. Zahn.
Marine Ecology Progress Series MESEDT, Vol. 57, No. 3, p 307-310, November 10, 1989. 2 fig, 2 tab, 16 ref.

Descriptors: *Adriatic Sea, *Aquatic bacteria, *Bioassay, *Phytoplankton, *Water pollution effects, *Eutrophication, *Toxicity, *Marine sediments, Bacterial bioluminescence, Municipal wastewater, Industrial wastewater, Water pollution, Decomposing organic matter, Yugoslavia.

The toxicity of selected sediments in the Adriatic Sea and the effect of phytoplankton bloom on sediments in the vicinity of Rovinj, Yugoslavia, using bacterial bioluminescence toxicity assay, were investigated. Sediments under the influence of urban and industrial wastes tend to be more contaminated than those in the open sea. The toxic effect of decayed material derived from sinking mucus aggregates was higher at locations influenced by local pollution. A 10-fold increase in the toxicity of sediments followed an increase in (EOM) extractable organic matter. This is in agreement with the measured increase in (TOM) total organic matter caused by continuous sedimentation of decayed material. At the end of August the bulk of decayed material had settled into the sediment surface. No further increase in extractable organic matter and toxicity was observed. Six months later, both the EOM and toxicity decreased to the level measured prior to the bloom. These results suggested that the increase in toxicity of sediment extracts could be explained mainly as a consequence of changes in organic matter derived from the decayed products of mucus aggregates. (Author's abstract)
W90-04655

USE OF REMOTELY SENSED SOIL MOISTURE CONTENT AS BOUNDARY CONDITIONS IN SOIL-ATMOSPHERE WATER TRANSPORT MODELING: 1. FIELD VALIDATION OF A WATER FLOW MODEL.
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol.
For primary bibliographic entry see Field 2G.
W90-04660

USE OF REMOTELY SENSED SOIL MOISTURE CONTENT AS BOUNDARY CONDITIONS IN SOIL-ATMOSPHERE WATER TRANSPORT MODELING: 2. ESTIMATING SOIL WATER BALANCE.
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol.
For primary bibliographic entry see Field 2G.
W90-04661

APPARATUS FOR MONITORING AND CONTROLLING TURBIDITY IN BIOLOGICAL EXPERIMENTS.
Delaware Univ., Newark. Coll. of Marine Studies.
P. A. Grecay.
Marine Biology MBIOAJ, Vol. 103, No. 3, p 291-302, 1989. 4 fig, 18 ref.

Descriptors: *Laboratory equipment, *Measuring instruments, *Turbidity, *Marine environment, Suspended solids, Control systems, Computers, Biological studies.

Turbidity is an important ecological factor which affects feeding and growth in marine organisms. Because of the rapidity with which suspended

solids settle out of the water column in nonturbulent environments, maintenance of controlled levels of turbidity in laboratory investigations has been problematic. Ideally, turbidity levels should be measured and adjusted frequently enough to ensure no significant changes over time. A computer controlled, recirculating aquarium system is described which constantly monitors the turbidity in several treatment levels and responds appropriately to maintain treatments at the desired level. This system allows long-term turbidity experiments to be performed while continuously recording all turbidity measurements collected for each treatment during the course of the experiment. (Author's abstract)
W90-04728

SURVEYING THE ENTIRE RIVER ECOSYSTEM.
Anglian Water Authority, Lincoln (England). Lincoln Div.
For primary bibliographic entry see Field 2H.
W90-04732

APPLICATION OF MICROSCOPIC EXAMINATION OF ACTIVATED SLUDGE TO OPERATIONAL CONTROL.
Southern Water Authority, Chatham (England). Kent Div.
For primary bibliographic entry see Field 5D.
W90-04736

COMPLEXING OF COPPER IN DRINKING WATER SAMPLES TO ENHANCE RECOVERY OF AEROMONAS AND OTHER BACTERIA.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5F.
W90-04811

FINITE ELEMENT ANALYSIS OF EFFECT OF PIPE COOLING IN CONCRETE DAMS.
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
For primary bibliographic entry see Field 8A.
W90-04814

MANAGEMENT MODEL FOR CONTROL OF ON-FARM IRRIGATION.
Kansas State Univ., Manhattan. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-04817

ANALYTICAL MODEL FOR BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-04819

INVERTED V-NOTCH: PRACTICAL PROPORTIONAL WEIR.
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
K. K. Murthy, and D. P. Giridhar.
Journal of Irrigation and Drainage Engineering (ASCE) JIJDH, Vol. 115, No. 6, p 1035-1050, December 1989. 12 fig, 2 tab, 9 ref.

Descriptors: *Weirs, *Discharge measurement, *Hydraulics, *Irrigation engineering, Wastewater facilities, Grit chambers, Environmental engineering, Flow control.

Linear proportional weirs have recently attracted considerable interest because of their wide application in allied fields as a simple discharge measuring device in irrigation engineering, as a grit-chamber outlet in wastewater disposals for controlling velocities in environmental engineering, or as a dosing device in chemical engineering. This paper presents a practical linear proportional weir of simple geometric shape in the form of an inverted V-notch or inward trapezium. The flow through

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this weir, of half-width w and altitude d , for depths above $0.22d$ is proportional to the depth of flow measured above a reference plane situated at $0.08d$ for all heads in the range $0.22d < h < 0.94d$, with a maximum percentage deviation of ± 1.5 from the theoretical discharge. The linear relationship between head and discharge is based on numerical optimization procedures. Nearly 75% of the depth of inverted V-notch can be used effectively as the measuring range. Experiments with four weirs, with different vertex angles, show excellent agreement with the theory by giving an average coefficient of discharge for each weir varying from 0.61-0.62. (Author's abstract) W90-04823

AUTOMATIC SAMPLING EQUIPMENT AND BOD TEST NITRIFICATION.

Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 5D. W90-04844

STRUCTURAL INVESTIGATIONS OF AQUATIC HUMIC SUBSTANCES BY PYROLYSIS-FIELD IONIZATION MASS SPECTROMETRY AND PYROLYSIS-GAS CHROMATOGRAPHY/MASS SPECTROMETRY.

Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
G. Abbt-Braun, F. H. Frimmel, and H. R. Schulten.
Water Research WATRAG, Vol. 23, No. 12, p 1579-1591, December 1989. 4 fig, 4 tab, 51 ref. Deutsche Forschungsgemeinschaft, Bonn-Bad Godesberg Projects Schu 416/8-1, Ru 251/6-5 and Fr 537/6-7.

Descriptors: *Humic acids, *Water analysis, *Molecular structure, *Chemical analysis, *Pyrolysis, *Mass spectrometry, *Gas chromatography, Metal complexes, Spectroscopy, Laboratory equipment.

The present state-of-the-art in structural investigations of aquatic humic substances and their fractions such as fulvic and humic acids by pyrolysis-field ionization mass spectrometry (py-FIMS) is outlined. An integrated approach to interpretation uses complementary data of elemental analysis, functional group determinations, Cu(+)-complexation, H(+)-capacity and results from ultraviolet-visible and Fourier-transform infrared spectroscopy. Proposed building blocks of the molecular structure are supported by chromatographic investigations using Curie-point pyrolysis-gas chromatography/mass spectrometry and the available literature reports. From pyrolysis of aquatic humic material combined with soft ionization FIMS, additional information for the characterization of humic substances can be deduced. The amount and variety of the substances represented and the wide mass range show advantages with regard to other degradative and pyrolytic methods. Especially accurate mass determinations has led to valuable inputs on the discussion of structural models for humic substances. However, py-FIMS is limited by the lack of final identification of the pyrolysis products, since the exact mass determination can only give the molecular formulas. Therefore, pyrolysis FIMS data have to be combined with the results from other spectroscopic methods and with chemical analysis. (Author's abstract) W90-04847

ORGANICS ISOLATION FROM FRESH AND DRINKING WATERS BY MACROPOROUS ANION-EXCHANGE RESINS.

Politechnika Warszawska (Poland). Faculty of Sanitary and Hydraulic Engineering.
For primary bibliographic entry see Field 5A. W90-04848

IC: A POWERFUL ANALYTICAL TECHNIQUE FOR ENVIRONMENTAL LABORATORIES.

Dionex Corp., Sunnyvale, CA.
R. J. Joyce, and A. Schein.
American Environmental Laboratory, Vol. 1, No. 2, p 46-53, November 1989. 7 fig, 2 tab, 8 ref.

Descriptors: *Ion chromatography, *Water analysis, *Chemical analysis, *Chromatography, *Pollutant identification, Conductivity, Organic compounds, Heavy metals, Drinking water, Technology.

One of the technologies singled out by the U.S. EPA report to meet the demanding environmental analysis challenge is ion chromatography (IC). Ion chromatography owes its rapid emergence to the integration of innovations in chemistry, chemical and mechanical engineering, and electronics. Probably the most important innovation is post-column chemical suppression of eluant conductivity. Since ions are charged species, conductivity measurement is generally the most effective method of detection. Thus, to get sensitive and accurate quantitative results, the conductivity of the analytes of interest must be greater than the conductivity of the eluant. Chemical suppression takes advantage of ion exchange-mediated acid-base neutralization reactions to remove eluant ions prior to measurement of analyte peaks. Ion chromatography is proving to be an excellent analytical technique for a wide array of environmental situations and has been used successfully for measuring: (1) anions in drinking water; (2) hexavalent chromium; (3) transition metals in complex matrices; and (4) organic contaminants. Recent work has shown that by coupling ion exchange separation with mass spectrometry analysis of wastewater, organic contaminants not found by gas chromatography or high performance liquid chromatography methods were present. (White-Reimer-PTT) W90-04850

USE OF SEGMENTED MICROCONTINUOUS FLOW ANALYSIS AND FIA IN WATER ANALYSIS.

ALPKEM Corp., Clackamas, OR.
M. R. Straka.
American Environmental Laboratory, Vol. 1, No. 2, p 60-63, November 1989. 1 fig, 1 tab, 6 ref.

Descriptors: *Chemical analysis, *Flow injection analysis, *Measuring instruments, *Water analysis, Industrial wastes, Detection limits, Precision, Water quality control.

Despite the development of many valuable alternative technologies for the determination of species such as nitrite, nitrate, ammonia, phosphate, sulfate, carbonate, and fluoride, in industrial wastes, continuous flow technology remains the most cost-effective means of determining inorganic species in a large number of samples. However, a number of changes have been made. The most notable change led to the development of nonsegmented flow injection analysis (FIA) in the late seventies and to micro segmented continuous flow systems in the early eighties. Segmented micro continuous flow analysis offers the water testing laboratory rapid sample determinations of up to 200 per hr, micro-liter sample and reagent usage, low ppb detection limits, plus the ability to perform on-line distillations. FIA is a dynamic technique; steady-state conditions do not apply at the point of detection. As a result, FIA sensitivities are, on average, 60-90% of the steady-state value attainable in a manual or segmented system. In order to attain lower detection limits, larger sample volumes can be injected. However, this results in greater dispersion and longer sample washout which leads to reduced sample throughput. A modern FIA system with state-of-the-art injection valves and peristaltic pumps offers the advantage of: (1) advanced measurement precision; (2) an array of on-line techniques that effectively modify difficult samples and their matrices; and (3) enhancement of the selectivity of an analytical method. (White-Reimer-PTT) W90-04851

COMPARISON OF CHEMICAL ANALYSES OF BOAT AND HELICOPTER-COLLECTED WATER SAMPLES.

Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV. Acid Deposition Dept. A. W. Groeger, M. B. Bonoff, J. R. Baker, and E. P. Meier.
Hydrobiology HYDRB8, Vol. 182, No. 2, p 161-

163, 1989. 1 tab, 7 ref. Research funded by the U.S. EPA through contract number 68-03-3249.

Descriptors: *Sampling, *Data acquisition, *Acid rain, *Helicopters, *Water Sampling, Lakes, Boats, Aircraft, Field tests, Comparison studies, Chemical analysis.

Helicopters can be used to collect water samples from many lakes over a wide geographic area within a relatively short time period. The results from an experiment in which sequential water samples from a lake were collected first from a nonmotorized boat and then immediately afterward from a helicopter are reported. No significant differences were found between the means of the measurement of 20 chemical parameters for the two methods of collection. When compared to obtaining samples from a boat, collection of samples from a helicopter platform had no effect on the content of the water samples. (Author's abstract) W90-04894

REFINEMENTS TO THE BOD TEST.

R. G. Tyers, and R. Shaw.
Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 3, No. 4, p 366-374, August 1989. 1 fig, 10 tab, 14 ref.

Descriptors: *Water analysis, *Biochemical oxygen demand, *Laboratory methods, *Water quality standards, Organic pollutants, Nitrification, Oxidation, Sample preservation, Precision, Performance evaluation.

For about 80 years the biochemical oxygen demand (BOD) has remained one of the major indicators of organic pollution in the water industry. While many adaptations and refinements have been made over the last 2-3 decades, one of the most significant was to suppress nitrification by the addition of allylthiourea (ATU) at 0.5 milligrams per liter, thus ensuring that only carbonaceous oxidation was measured. Evidence has accrued to show that, for some situations, this concentration is insufficient to fully suppress nitrification. Poor stability is a problem with biochemical oxygen demand when samples have to be stored prior to analysis, and a method of storage is proposed which minimizes instability. As an empirical bioassay procedure, the accuracy of BOD can be poor compared with alternative methods such as chemical oxygen demand; and problems with incubator and refrigerator temperatures, the preparation of standards, and replacement batteries for dissolved-oxygen probes are discussed. The aim of this paper is to show that these problems with biochemical oxygen demand can be eliminated, thereby retaining confidence in its use. (Author's abstract) W90-04908

NEW TECHNIQUE FOR MEASURING FINE SEDIMENT IN STREAMS.

Wyoming Univ., Laramie. Water Resources Research Inst.
T. A. Wesche, D. W. Reiser, V. R. Hasfurther, W. A. Hubert, and Q. D. Skinner.
North American Journal of Fisheries Management NAJMDP, Vol. 9, No. 2, p 234-238, Spring 1989. 1 fig, 2 tab, 10 ref.

Descriptors: *Measuring instruments, *Sediment sampler, *Bottom sediments, *Streams, Streambeds, Gravel, Cores, Performance evaluation.

Techniques commonly used to measure fine-sediment accumulation in streambed gravels can be labor and equipment intensive. We evaluated the sediment trapping capabilities of modified Whitlock-Vibert boxes under both laboratory and field conditions and compared the accumulated fine sediment to that contained in adjacent gravels as indicated by McNeil core samples. Our results suggest the boxes can be used as an alternative to core sampling for monitoring intergravel fine sediment levels. Advantages include ease of transport to remote field sites, small sample volumes, and reduced analysis time. Problems encountered were displacement of boxes by flood and ice flows and

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inundation by large sediment spills. (Author's abstract)
W90-04919

DETERMINATION OF CHLORIDE AND AVAILABLE CHLORINE IN AQUEOUS SAMPLES BY FLAME INFRARED EMISSION.
Baylor Univ., Waco, TX. Dept. of Chemistry. S. W. Kubala, D. C. Tilotta, M. A. Busch, and K. W. Busch.
Analytical Chemistry ANCHAM, Vol. 61, No. 24, p 2785-2791, December 1989. 4 fig, 4 tab, 42 ref.

Descriptors: *Water chemistry, *Chemical analysis, *Laboratory methods, *Chlorides, *Pollutant identification, *Flame photometry, *Water analysis, Chlorine, Detection limits, Precision, Infrared spectroscopy.

A specially designed system, using a flame infrared emission (FIRE) detector, was developed for the determination of chloride (Cl-) in water and available chlorine (Cl₂, HOCl, and OCl-) in liquid bleach. Chloride ion was converted to molecular chlorine (Cl₂) by addition of concentrated sulfuric acid and a saturated solution of potassium permanganate. Bleach samples were treated with sulfuric acid to convert all hypochlorite and hypochlorous acid to Cl₂. After treatment, molecular chlorine was purged from solution with He and introduced into a hydrogen/enriched-air flame. A portion of the HCl emission intensity at 3150-2425/cm was monitored using a lead selenide detector in conjunction with a 3.8-micron optical band-pass filter. Peak emission intensity measurements from repeated injections of aqueous NaCl standards gave a relative standard deviation of 3.34%, and calibration curves were linear up to the maximum concentration of chloride investigated (10 mM NaCl). The average relative standard deviations of the chloride and available chlorine determinations measured with the FIRE system were found to be 4.39% and 1.84%, respectively. The accuracy of the FIRE technique was determined by comparing the available chlorine results with those obtained by iodometric titration for three commercial bleach samples and was found to be 2.97%. The detection limit for chloride and available chlorine was 1.59 ppm and 1.61 ppm, respectively. Elevated levels of bromide produced a negative interference in the determination of chloride with the FIRE system, but iodide and phosphate did not interfere. (Author's abstract)
W90-04994

FURTHER RESEARCH ON APPLICATION OF PROBABILITY WEIGHTED MOMENTS IN ESTIMATING PARAMETERS OF THE PEARSON TYPE THREE DISTRIBUTION.
Chengdu Univ. of Science and Technology (China).
For primary bibliographic entry see Field 7C.
W90-05000

EXPRESSIONS RELATING PROBABILITY WEIGHTED MOMENTS TO PARAMETERS OF SEVERAL DISTRIBUTIONS INEXPRESSIBLE IN INVERSE FORM.
Chengdu Univ. of Science and Technology (China).
For primary bibliographic entry see Field 7C.
W90-05001

INSTRUMENTATION, CONTROL AND AUTOMATION: THE GRAMPIAN WAY.
Grampian Regional Council, Aberdeen (Scotland). Dept. of Water Services.
For primary bibliographic entry see Field 5F.
W90-05012

DAILY AVERAGE VALUE OF UN-IONIZED AMMONIA FROM FIELD MEASUREMENTS.
For primary bibliographic entry see Field 2H.
W90-05031

DIRECT DETECTION OF ORGANIC COMPOUNDS IN WATER AT PARTS-PER-BILLION

LEVELS USING A SIMPLE MEMBRANE PROBE AND A QUADRUPOLE ION TRAP.
Purdue Univ., Lafayette, IN. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W90-05038

Absorption Coefficient of Particulate Matter in Lake Haruna.
Gunma Univ., Maebashi (Japan). Faculty of Education.
For primary bibliographic entry see Field 2H.
W90-05054

USE OF TRACER TESTS TO MEASURE THE TRANSPORT AND CONSUMPTION OF METHANE IN A CONTAMINATED AQUIFER.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-05078

USE OF RADON-222 AS A TRACER OF TRANSPORT ACROSS THE BED SEDIMENT-WATER INTERFACE IN PRIEN LAKE, LOUISIANA.
Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W90-05092

COMPARISON OF INSTRUMENTAL DEWATERING METHODS FOR THE SEPARATION AND CONCENTRATION OF SUSPENDED SEDIMENTS.
Geological Survey, Doraville, GA.
A. J. Horowitz, K. A. Elrick, and R. C. Hooper.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p485-493, 4 tab, 15 ref.

Descriptors: *Water analysis, *Chemical analysis, *Trace elements, *Suspended sediments, *Dewatering, Filtration, Centrifugation, Particle size, Laboratory methods.

A comparison involving field and laboratory trials was performed to evaluate the utility of two continuous-flow centrifuges and a tangential-flow filtration system for dewatering suspended sediments for trace-element analysis. Although recovery efficiencies for the various devices differed, the analytical results from the separated suspended sediments indicate that any of the tested units can be used effectively and precisely for dewatering. Further, the three devices appear to concentrate and dewater suspended sediments in such a manner as to be equivalent to that which could be obtained by in-line filtration. The continuous-flow centrifuges can process whole water at an influent feed rate of 4 L/min; however, if (1) suspended-sediment concentrations are low (less than 30 mg/L), (2) small volumes of whole water are to be processed (30 to 40 L), or (3) suspended sediment mean grain size is very fine (less than 10 micrometers), influent feed rates of 2 L/min may be more efficient. Tangential-flow filtration can be used to process samples at the rate of 1 L/min. (See also W90-05059) (Author's abstract)
W90-05112

COMPARISON OF WELL-PURGING CRITERIA FOR SAMPLING PURGEABLE ORGANIC COMPOUNDS.
Geological Survey, West Trenton, NJ.
J. Gibbs, and T. E. Imbrigiotta.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p495-500, 1 fig, 1 tab, 13 ref.

Descriptors: *Water analysis, *Water sampling, *Data quality control, *Groundwater data, Water quality, Well purging, Comparison studies.

Groundwater sampling protocols generally recommend that a well be purged prior to sampling. This recommendation is based on the assumption that

the water quality of the water standing in the casings is not the same as that in the aquifer. Two criteria that generally have been used to determine when a well has been purged sufficiently to yield 'representative' water quality samples are: (1) flushing a recommended number of casing volumes, usually a minimum of three; and (2) flushing the well until field water quality characteristics—temperature, pH, specific conductance and dissolved oxygen—in the purge water are stable. The primary purpose of the this study was to evaluate the effectiveness of these criteria in sampling for purgeable organic compounds. The results indicate that: (1) purgeable organic compound concentrations stabilized when three casing volumes were purged in only 55% of the cases evaluated in this study; and (2) purgeable organic compound concentrations did not consistently follow the temporal variation of, nor stabilize at the same time as, the measured field water quality characteristics. The conclusion from these data is that neither of the previously recommended criteria for purging a well can be reliably applied to collecting a 'representative' sample for purgeable organic compounds. (See also W90-05059) (Author's abstract)
W90-05113

SAMPLING, FRACTIONATION, AND DEWATERING OF SUSPENDED SEDIMENT FROM THE MISSISSIPPI RIVER FOR GEOCHEMICAL AND TRACE-CONTAMINANT ANALYSIS.
Geological Survey, Denver, CO.
J. A. Leenheer, R. H. Meade, H. E. Taylor, and W. E. Pereira.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p501-511, 4 fig, 2 tab, 6 ref.

Descriptors: *Water analysis, *Mississippi River, *Water sampling, *Chemical analysis, *Data quality control, Suspended sediments, Particle size, Separation techniques, Silt, Clays, Organic carbon, Nitrogen.

The Mississippi River and its major tributaries were sampled at 17 sites located just upstream from St. Louis, Missouri, downstream to New Orleans, Louisiana, during two sampling trips in July-August 1987 and November-December 1987. Approximately 100 L of water and suspended sediment were representatively sampled at each site in a Lagrangian sampling pattern. Suspended sediment was separated by size at each site into sand by sieving, silt was separated by gravitational settling or continuous-flow centrifugation, and clay was separated by tangential-flow ultrafiltration. Various aliquots of the water-sample and suspended-sediment-size fractions were split among 17 researchers for determinations of suspended-sediment concentration, particle and mineralogical characteristics, radionuclide content, and organic geochemistry of natural constituents. Sampling and fractionation equipment was custom fabricated to ensure compatibility and prevent sampling contamination for all analysis. Recoveries of suspended sediment ranged from 72-94%; recovery was directly related to suspended-sediment concentration. The clay fraction had 1.5 to 5 times the organic-carbon content of the silt fraction; the carbon-to-nitrogen ratio of the clay fraction was 6 to 9, whereas the ratio of the silt fraction was 9 to 14. (See also W90-05059) (Author's abstract)
W90-05114

COLLECTION AND ANALYSIS OF UNSATURATED-ZONE SOIL GAS FOR VOLATILE ORGANIC COMPOUNDS.
Geological Survey, Arvada, CO.
For primary bibliographic entry see Field 5A.
W90-05126

ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY'S HYDROLOGIC INSTRUMENTATION FACILITY IN SUPPORT OF HAZARDOUS-AND TOXIC-SUBSTANCES PROGRAMS.
U.S. Geological Survey, Stennis Space Center,

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Mississippi.

J. H. Ficken, and D. Y. Tai.

IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p 625-631, 6 fig.

Descriptors: *Water analysis, *Chemical analysis, *Instrumentation, *Data acquisition, *Samplers, *Measuring instruments, *Laboratory equipment, Research, US Geological Survey.

The Hydrologic Instrumentation Facility has nationwide responsibility within the U.S. Geological Survey for hydrologic instrumentation research, development, testing, evaluation, procurement, warehousing, distribution, repair, and calibration. Support activities for the Survey's hazardous-substances and toxic-substances programs include warehouse operations, electronic and mechanical shops, test and evaluation services, instrument development and application, and information dissemination. Facility support of field activities fall into several areas. Personal protective gear, including breathing apparatus; field gas chromatographs; portable gas analyzers; toxic-gas monitors; and sampling pumps are stocked in the warehouse and are available to Survey field personnel. Personnel at the Facility have recently built mechanical prototypes of dewatering equipment, such as centrifuges and filters. Testing and evaluation performed at the Facility ensure that instrumentation available is capable of meeting Survey data-collection requirements. Sampling pumps have been designed that can prevent contamination of water during pumping. A standpipe and well have been installed to evaluate ground-water samplers and other instrumentation. As part of instrument development and application, pressure transducers and water-quality instrumentation are being evaluated in conjunction with a recently developed downhole sampler and data logger. Facility publications communicate technical information to the field. (See also W90-05059) (Author's abstract)
W90-05127

DETERMINATION OF CALCIUM, MAGNESIUM, AND SODIUM IN WASTEWATER BY INDUCTIVELY COUPLED PLASMA SPECTROSCOPY.

Westinghouse Materials Co. of Ohio, Cincinnati. Feed Materials Production Center.
For primary bibliographic entry see Field 5D.
W90-05135

NEW RADAR TECHNIQUE FOR SATELLITE RAINFALL ALGORITHM DEVELOPMENT.

Applied Research Corp., Landover, MD.
A. R. Jameson.
Available from the National Technical Information Service, Springfield, VA 22161, as N89-11102. Price codes: A03 in paper copy, A01 in microfiche. Applied Research Corporation Report R87-157, September 1987. 13p, 18 ref.

Descriptors: *Remote sensing, *Radar, *Satellite technology, *Rainfall, Data acquisition, Algorithms, Precipitation, Rainfall rate, Mathematical studies.

A potential new radar parameter for measuring rainfall was investigated. This parameter is the summation of the phase shifts (at horizontal and vertical polarizations) due to propagation through precipitation. The proposed radar technique has several potential advantages over other approaches because it is insensitive to the drop size distribution and to the shapes of the raindrops. Results of this investigation showed, however, that these phase shifts can not be measured by radar. However, a closely related radar parameter (propagation differential phase shift) can be readily measured using a polarization diversity radar. While it too is insensitive to the drop size distribution, it is a function of the mean shape of the raindrops. This dependence of the propagation differential phase shift on raindrop shape, however, can be accounted for when estimating the rain water content by using simultaneously measured differential reflectivity and the magnitude of the cross-correlation function

between horizontally and vertically co-polarized backscattered waves. Differential propagation phase shift, therefore, has the potential to be an important new tool for the radar measurement of rainfall. It is recommended that propagation differential phase shift be further investigated and developed for radar monitoring of rainfall using a polarization agile radar. (Lantz-PTT)
W90-05139

FINAL REPORT ON THE COOPERATIVE VAS PROGRAM WITH THE MARSHALL SPACE FLIGHT CENTER.

Wisconsin Univ.-Madison. Cooperative Inst. for Meteorological Satellite Studies.
G. R. Diak, and W. P. Menzel.
Available from the National Technical Information Service, Springfield, VA 22161, as N89-11361. Price codes: A04 in paper copy, A01 in microfiche. July 1988. 141p, 5 fig, 4 tab, 11 ref, append. NASA Grant No. NAS8-24732.

Descriptors: *Meteorology, *Water vapor, *Remote sensing, *Satellite technology, *Precipitation, *Weather forecasting, Cloud liquid water, Classification, Data acquisition.

Over the life span of this NASA-VAS (National Aeronautics and Space Administration-VISSR Atmospheric Sounder) cooperative program, work has been divided between analysis/forecast model development and evaluation of the impact of satellite data in mesoscale numerical weather prediction and also development of the Multispectral Atmospheric Mapping Sensor (MAMS) and related research. The modeling effort has seen the Cooperative Institute for Meteorological Satellite Studies Synoptic Scale Model progress from a relatively basic analysis/forecast system at the inception of the program to a package which now includes such features as nonlinear vertical model initialization, comprehensive Planetary Boundary Layer physics and the core of a fully four-dimensional data assimilation package which will be expanded on for subsequent NASA sponsored research. The MAMS effort has produced a calibrated visible and infrared sensor that produces imagery at high spatial resolution. The MAMS has been developed in order to study small scale atmospheric moisture variability, to monitor and classify clouds, and to investigate the role of surface characteristics in the production of clouds, precipitation, and severe storms. The NASA-VAS cooperative program has been the starting point for the testing of this aircraft instrument: the design of a future space-borne sensor in low earth or geostationary orbit with similar monitoring capabilities is planned. This effort has demonstrated good quality data from the MAMS from intercomparison with other instruments. (Lantz-PTT)
W90-05168

ACCURACY OF ACOUSTIC VELOCITY MEETING SYSTEMS FOR MEASUREMENT OF LOW VELOCITY IN OPEN CHANNELS.

Geological Survey, Tallahassee, FL. Water Resources Div.
A. Laenen, and R. E. Curtis.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4090, 1989. 15p, 6 fig, 8 tab, 7 ref. USGS Project FL-001.

Descriptors: *Flowmeters, *Instrumentation, *Gaging, *Flow velocity, *Acoustics, *Flow measurement, Stream gages, Error analysis.

Acoustic velocity meter (AVM) accuracy depends on equipment limitations, the accuracy of acoustic-path length and angle determination, and the stability of the mean velocity to acoustic-path velocity relation. Equipment limitations depend on path length and angle, transducer frequency, timing oscillator frequency, and signal-detection scheme. Typically, the velocity error from this source is about ± 0.1 to ± 0.10 mms/sec. Error in acoustic-path angle or length will result in a proportional measurement bias. Typically, an angle error of one degree will result in a velocity error of 2%, and a path-length error of one meter in 100 meter

will result in an error of 1%. Ray bending (signal refraction) depends on path length and density gradients present in the stream. Any deviation from a straight acoustic path between transducer will change the unique relation between path velocity and mean velocity. These deviations will then introduce error in the mean velocity computation. Typically, for a 200-meter path length, the resultant error is less than one percent, but for a 1,000 meter path length, the error can be greater than 10%. Recent laboratory and field tests have substantiated assumptions of equipment limitations. Tow-tank tests of an AVM system with a 4.69-meter path length yielded an average standard deviation error of 9.3 mms/sec, and the field tests of an AVM system with a 20.5-meter path length yielded an average standard deviation error of 4 mms/sec. (USGS)
W90-05190

CANAL AUTOMATION PROVIDING ON-DEMAND WATER DELIVERIES FOR EFFICIENT IRRIGATION.

California Polytechnic State Univ., San Luis Obispo. Dept. of Agricultural Engineering.
C. M. Burt, and J. P. Parrish.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-11979/AS. Price codes: A11 in paper copy, A01 in microfiche. Final Report, August 1989. 238p, 27 fig, 16 tab, 12 ref, 21 append. USGS Contract 14-08-0001-G1280.

Descriptors: *Algorithms, *Canals, *Irrigation efficiency, *Computer models, *Flow control, *Simulation analysis, *Water demand, Model studies, Automation.

An algorithm for downstream control of sloping canals (CARD) was refined and tested using both computer simulations and a 200 m long physical model canal with six pools. CARD uses independent controllers and computes upstream gate movements based upon three water levels, controlling a setpoint at the downstream end of a pool. Rules for successful CARD implementation were determined. In simulations CARD was transferable between different canals with little or no modification. Large (greater than 25% of canal capacity), multiple turnout changes could be made and stability was achieved rapidly in almost all cases. (USGS)
W90-05202

EVALUATION OF FIELD SAMPLING AND PRESERVATION METHODS FOR STRONTIUM-90 IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.
For primary bibliographic entry see Field 5A.
W90-05278

INFLUENCE OF SALINITY, LEACHING FRACTION, AND SOIL TYPE ON OXYGEN DIFFUSION RATE MEASUREMENTS AND ELECTRODE POISONING.

Nevada Univ., Reno. Dept. of Plant Science.
D. A. Devitt, L. H. Stolzy, W. W. Miller, J. E. Campana, and P. Sternberg.
Soil Science SOSCAK, Vol. 148, No. 5, p. 327-335, Nov 1989. 11 fig, 2 tab, 18 ref.

Descriptors: *Instrumentation, *Soil chemistry, *Soil water, *Oxygen requirements, *Ion-selective electrodes, Saline soils, Leaching, Soil types, Platinum electrodes.

An experiment was conducted in 27 large columns to determine the impact of soil type (sandy loam, silt loam and clay), salinity of irrigation water (1.5, 3.0, and 6.0 dS/m), and leaching fraction (drainage/irrigation, 0.09, 0.18, and 0.27) on oxygen diffusion rate measurements (ODR) taken with platinum electrodes. Electrodes were left in place (15, 30, and 60 cm deep), and ODR was measured over a 6-mo period. At the end of 6 mo, electrodes were removed and observed under a low-magnification

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microscope for the presence or absence of precipitate. Selected electrodes were then photographed under a scanning electron microscope, analyzed using x-ray diffraction techniques, and analyzed for percentage of atom composition using x-ray photoelectron spectroscopy. Results indicated that soil type, salinity, and leaching fraction all influenced ODR measurements. The formation of precipitate on the platinum electrodes was observed equally in all three soils, but to a greater extent under high salinity and low leaching fraction conditions at the greater depths. Precipitate composition was similar to soil composition in both the silt loam and clay soils, but poor agreement was observed in the sandy loam soil, as indicated by Si/Al and C/O ratios. Results would suggest that aluminosilicates were either incorporated into calcium carbonate as it precipitated out of solution onto the platinum or platinum oxides in the presence of high salinity and calcium were bridged to aluminosilicates through a charged exchange reaction. (Author's abstract) W90-05307

DETERMINATION OF LOW LEVEL SULFIDES IN ENVIRONMENTAL WATERS BY AUTOMATED GAS DIALYSIS/METHYLENE BLUE COLORIMETRY.

Alberta Environmental Centre, Vegreville.
For primary bibliographic entry see Field 5A.
W90-05312

IMMOBILIZED 8-OXINE UNITS OF DIFFERENT SOLID SORBENTS FOR THE UPTAKE OF METAL TRACES.

Turin Univ. (Italy). Dpt. di Chimica Analitica.
O. Abollino, E. Mentasti, V. Porta, and C. Sarzanini.
Analytical Chemistry ANCHAM, Vol. 62, No. 1, p 21-26, January 1, 1990. 2 fig, 7 tab, 28 ref.

Descriptors: *Sorption, *Trace metals, *Chemical analysis, *Chelating agents, *Water analysis, *Heavy metals, *Pollutant identification, *Oxine, Substrates, Metals, Enrichment, Resins, Yield, Spectroscopy, Model testing, Detection limits.

Different solid sorbents have been used for the immobilization of organic ligands. Such substrates have been used for the uptake of metal ion traces from aqueous samples and for their enrichment, under different operating mechanisms of ligands and of complex retention. Among the grafted ligands, 8-hydroxyquinoline (oxine) has been extensively used in different forms, especially grafted to controlled-pore glass, or adsorbed on octadecyl reversed-phase silica. The sorption of 8-hydroxyquinoline and 8-hydroxyquinoline-5-sulfonic acid (SOX) in a polystyrene-divinylbenzene resin (Amberlite XAD-2) and on an anion exchange resin (Bio-Rad AG MP-1) has been used for the uptake and enrichment of trace metal ions. The investigated metal ions were Cu(II), Cd(II), Cu(II), Mg(II), Mn(II), Ni(II), Pb(II), and Zn(II). The uptake and recovery yields were determined by use of inductively coupled plasma atomic emission spectroscopy. The behavior of the sorbed ligands was determined in different conditions, and the results have been discussed and compared with those computed according to a described model. The chelating solid substrates have been used for enrichment of metal traces from environmental samples. Enrichment factors of up to 100, together with low blank levels of the optimized procedures, allow the simple determination of the above elements at concentrations down to a few nanograms per mL. The use Ag MP-1 + SOX appeared superior with respect to XAD-2 + oxine, as pointed out by the effect of interferents on the recovery and enrichment. (Author's abstract) W90-05313

GAS SENSOR AND PERMEATION APPARATUS FOR THE DETERMINATION OF CHLORINATED HYDROCARBONS IN WATER.

Illinois Inst. of Tech., Chicago. Dept. of Chemistry.
J. R. Stetter, and Z. Cao.
Analytical Chemistry ANCHAM, Vol. 62, No. 2, p 182-185, January 15, 1990. 7 fig, 3 tab, 15 ref.

Descriptors: *Water analysis, *Wastewater analysis, *Chlorinated hydrocarbons, *Pollutant identification, *Chemical analysis, *Sensors, *Permeable membranes, Monitoring, Process water, Electronic equipment, Water sampling, Chlorobenzene, Selectivity.

The on-line determination of specific chlorinated hydrocarbons in wastewater is an important analytical problem. On-line process monitoring or screening methods that could be applied in the field would benefit from a low-cost alternative for the determination of chlorinated hydrocarbons. A solid-state sensor with a selective response to chlorinated hydrocarbons has been combined with a simple silicone rubber permeation apparatus. The apparatus has been tested in a way that simulates the on-line analysis of chlorinated hydrocarbons in a liquid process stream. The system can provide information on whether or not the sampled stream contains chlorinated hydrocarbons as well as quantitation of chlorinated hydrocarbons in the sample. No sensor response was observed for 1000 ppm hexane or phenol while concentrations of a few ppm of chlorobenzene were easily detected. The permeation apparatus offers a new and convenient method to analyze the contents of an aqueous sample while using a gas sensor. Since many more types of gas sensors are convenient and available than are liquid sensors, this approach may be more generally useful if other gas sensors are interfaced to the liquid sampling system by means of semipermeable membrane technology. (Author's abstract) W90-05314

GAS-CHROMATOGRAPHIC ANALYSIS OF CHLORINATED ACIDS IN DRINKING WATER.

Glenmore Waterworks Lab., Calgary (Alberta).
For primary bibliographic entry see Field 5A.
W90-05316

ISOLATION OF HUMIC AND ADHERENT ORGANIC SUBSTANCES IN PREPARATIVE SCALE FROM GROUNDWATER AND SURFACE WATER UNDER FIELD CONDITIONS BY MEANS OF A MOBILE ADSORPTION DEVICE.

Ruhr Univ., Bochum (Germany, F.R.). Inst. fuer Hygiene.
A. Hack, and F. Selenka.
Aqua AQUAAA, Vol. 30, No. 6, p 369-375, 3 fig, 2 tab, 24 ref. December 1989.

Descriptors: *Humic substances, *Organic matter, *Separation techniques, *Sampling, *Water sampling, *Laboratory equipment, Isolation, Field tests, Adsorption, Water analysis, Resins, Anaerobic conditions, Groundwater, Surface water.

For the investigation of inorganic, organic or biological turnover and of transportation processes of substances in the aquatic environment, large quantities of humic material from various sampling sites may be needed. Because of the relative small concentration of humic substances (HS) in most natural waters the material required has to be isolated from large volumes of water. A column-chromatographic method with macroporous hydrophobic styrene-divinylbenzene resin XAD-2 for operation under field conditions, and working on a semi-technical scale, is described. One thousand to 7000 L of acidified water sample are passed over XAD-2 columns. Adsorbed material is eluted by means of increase in pH or by organic eluents such as methanol or methanol-ammonium; 30-85% of the dissolved organic carbon in water could be extracted. The isolation process is performed under low risk of contamination and under strict anaerobic conditions. After extraction, HS are concentrated by gentle vacuum-drying and final lyophilization, thus rendering a fine brownish water-soluble powder. Quantities of HS in the range of 5-25 g were isolated under anaerobic conditions with low risk of contamination. (VerNooy-PTT) W90-05319

TEMPORAL AND SPATIAL VARIATION IN PELAGIC FISH ABUNDANCE IN LAKE MEAD DETERMINED FROM ECHOGRAMS.

Nevada Univ., Las Vegas. Lake Mead Limnological Research Center.
For primary bibliographic entry see Field 8I.
W90-05324

LIPID SYNTHESIS BY ISOLATED DUCK-WEED (LEMNA MINOR) CHLOROPLASTS IN THE PRESENCE OF A SUBLETHAL CONCENTRATION OF ATRAZINE.

Sherbrooke Univ. (Quebec). Dept. de Biologie.
For primary bibliographic entry see Field 4A.
W90-05351

USE OF ROOTS TRANSFORMED BY AGROBACTERIUM RHIZOGENES IN RHIZOSPHERE RESEARCH: APPLICATIONS IN STUDIES OF CADMIUM ASSIMILATION FROM SEWAGE SLUDGES.

Institut National de la Recherche Agronomique, Versailles (France). Lab. de Biologie de la Rhizosphere.

D. Tepfer, L. Metzger, and R. Post.
Plant Molecular Biology PMBIDB, Vol. 13, No. 3, September 13, 1989. 1 fig, 1 tab, 59 ref.

Descriptors: *Sludge, *Cadmium, *Rhizosphere, *Bacterial physiology, *Plant physiology, *Roots, Heavy metals, Culturing techniques, Waste-assimilative capacity.

The usefulness of roots transformed by Agrobacterium rhizogenes in rhizosphere research was investigated with the aid of an example: the study of cadmium availability in sewage sludges. A list of species for which transformed root cultures is provided and the example of studies of cadmium assimilation from sewage sludge is given to illustrate how transformed root cultures can be used in physiological tests under non-sterile conditions. In order to assay cadmium availability, dry sewage sludge was diluted with highly purified water and added to transformed calystegia cultures that had been rinsed in the same water. The control consisted of roots treated in the same manner, but the sewage sludge was replaced by sufficient cadmium nitrate to reproduce the total cadmium concentration in the sewage sludge. Representative results show that the cadmium was less available in the sewage sludge than in the salt. The difference represents the affinity of the sludge for the contaminating cadmium when plant roots are present. Sludges of different origin respond differently in this bioassay for cadmium availability, indicating that transformed roots can be used to distinguish between the availability of cadmium in different sludges. (Author's abstract) W90-05382

SERIOUS INHIBITION PROBLEM FROM A NISKIN SAMPLER DURING PLANKTON PRODUCTIVITY STUDIES.

University Coll. of North Wales, Bangor. School of Ocean Sciences.
P. J. L. Williams, and J. I. Robertson.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1300-1305, November 1989. 5 tab, 17 ref. NERC Research Award GR3/5549.

Descriptors: *Photosynthesis, *Chlorophyll, *Samplers, *Primary productivity, Seawater, Respiration, Hydrologic data collections, Indian Ocean, Error analysis, Niskin sampler.

Low photosynthetic rates and reductions in chlorophyll concentrations were observed in incubations of samples taken with a 30-liter Niskin sampler during productivity studies of oligotrophic waters in the Indian Ocean. By contrast, there appeared to be no effect on community respiration. The rates of photosynthesis were 5-fold to 10-fold greater in samples taken with Teflon-lined 10-liter GoFlo bottles, and there was no systematic loss of chlorophyll. The central rubber cord of the Niskin sampler was identified as a potent source of contamination. If it is not possible to replace Niskin bottles for sampling, it is essential to replace the central cord of neoprene or latex rubber with silicone or epoxy-coated stainless steel springs and

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the neoprene O-rings with their silicone equivalents. (Author's abstract)
W90-05397

CARBON ISOTOPIC COMPOSITIONS OF ESTUARINE BACTERIA.

Gordon Coll, Wenham, MA. Dept. of Biology. R. B. Coffin, B. Fry, B. J. Peterson, and R. T. Wright.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1305-1310, November 1989. 2 fig, 2 tab, 25 ref. NSF Grants OCE 83-20455 and BSR 87-04738.

Descriptors: *Bioassay, *Carbon, *Stable isotopes, *Aquatic bacteria, *Estuaries, Primary productivity, Growth, Organic carbon, Plankton, Spartina, Isotopic tracers.

A bioassay was developed to assess the stable carbon isotopic compositions of planktonic bacteria from the Parker River estuary, Massachusetts. A small inoculum of natural bacteria was added to filtered estuarine water, then incubated for 24-48 hr until bacteria reached the end of log-phase growth. Bacteria harvested at the end of these bioassays exhibited a wide range of delta-C13 values from -11.5 parts per thousand (ppt) (near the -13 ppt value of Spartina) to -27.4 ppt (near the -29 ppt value of upland C-3 plants). This wide range of delta-C13 values suggest that bacteria in the estuary use substrates from a variety of primary producers. Experiments with glucose and dissolved organic carbon leached from oak and Spartina leaves showed that bacteria had delta-C13 values within +/-2 ppt of their growth substrates. The results suggest that carbon isotopic measurements are useful for tracing the linkage between bacteria and the plant sources of substrates that support bacterial growth. (Author's abstract)
W90-05398

ANOMALOUS, SHORT-TERM INFLUX OF WATER INTO SEEPAGE METERS.

Alberta Univ., Edmonton. Dept. of Zoology. R. D. Shaw, and E. E. Prepas.
Limnology and Oceanography LIOCAH, Vol. 34, No. 7, p 1343-1351, November 1989. 7 fig, 1 tab, 12 ref.

Descriptors: *Seepage meters, *Instrumentation, *Measuring instruments, *Seepage, *Error analysis, Performance evaluation, Monitoring.

Laboratory and field tests revealed that there was an anomalous, short-term influx of water into plastic bags after they were attached to seepage meters. Plastic bags (3.5-liter capacity) were submerged in an 830-liter tank of stagnant water; within 45 min, the volume of water in bags that initially were empty increased to 297 ml, bags prefilled with 1,000 and 2,000 ml of water increased by 160 ml, and bags prefilled with 3,000 ml decreased in volume. At Narrow Lake, Alberta, the anomalous, short-term (30-min) influx of water averaged 237 ml to bags that were initially empty, but the anomaly was effectively eliminated when bags were prefilled with 1,000 ml of water before they were attached to seepage meters. The impact of the anomaly on calculated seepage rates was greatest when seepage rates were low, e.g. 0.3 ml/sq m/min. The anomaly may be due to mechanical properties of the bag, and it may be alleviated by partially filling bags before they are attached to seepage meters. (Author's abstract)
W90-05401

LOSS OF TOTAL SULFUR AND CHANGES IN SULFUR ISOTOPIC RATIOS DUE TO DRYING OF LACUSTRINE SEDIMENTS.

Manitoba Univ., Winnipeg. Dept. of Microbiology. For primary bibliographic entry see Field 2H.
W90-05402

ALTERATION OF PHOSPHORUS DYNAMICS DURING EXPERIMENTAL EUTROPHICATION OF ENCLOSED MARINE ECOSYSTEMS.

Rhode Island Univ., Narragansett. Marine Ecosystems Research Lab.

For primary bibliographic entry see Field 5C.
W90-05410

NEW SCREENING TEST TO DETERMINE THE ACCEPTABILITY OF 0.45-MICRON MEMBRANE FILTERS FOR ANALYSIS OF WATER.

Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W90-05482

USE OF HYDROLOGY IN RIPARIAN CLASSIFICATION.

Bureau of Land Management, Boise, ID. Idaho State Office. K. A. Gebhardt, C. Bohn, S. Jensen, and W. S. Platts.
IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 53-59. 6 fig, 17 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Classification, *Stream classification, *Environmental quality, *Riparian waters, *Riparian land, Erosion, Soil water, Streams, Hydrology, Stream profiles.

A concept of 'state' is introduced to help deal with units of classification. State is a flexible unit and can represent many types of classification units as required by the user. The state represents the likely appearance of a riparian site based on various environmental conditions. In this study, environmental conditions are expressed in terms of erosion resistance and soil water. Soil water is the persistence of the source of soil water and/or the ability of the soil to hold and release moisture to vegetation. Erosion resistance is described by vegetation condition and substrate texture. A riparian classification and/or site description should include sufficient process information to help determine cause and effect, as well as management options. The following information should be included in the classification description: (1) description of substrates and soil, (2) relation of various discharge amounts to channel capacity and function, (3) description of the general flow regime during the year, and (4) description of ground and surface water behaviors typically encountered on the site. In preparing a hydrologic description for riparian classification purposes, water regime and influence of riparian systems, floodplain and channel interaction, and groundwater behavior are also important considerations. Future investigation and classification efforts need to identify the roles and interactions of hydrology to improve the understanding and management of riparian systems. (See also W90-05491) (Mertz-PTT)
W90-05500

MODELING OF PHYSICAL AND BEHAVIORAL MECHANISMS INFLUENCING RECRUITMENT OF SPOT AND ATLANTIC CROAKER TO THE CAPE FEAR ESTUARY.

Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 2L.
W90-05543

DEVELOPMENT OF A CAPILLARY WICK UNSATURATED ZONE PORE WATER SAMPLER.

Texas Agricultural Experiment Station, College Station. K. W. Brown, J. C. Thomas, and M. W. Holder.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129100. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/4-88/001, January 1988. 105p, 32 fig, 9 tab, 18 ref, 2 append.

Descriptors: *Instrumentation, *Samplers, *Measuring instruments, *Soil water, *Interstitial water, *Water sampling, Vadose water, Hydraulic conductivity, Capillary water.

Existing unsaturated zone soil water samplers have several deficiencies which jeopardize their utility

for field sampling. Suction cups only function when a vacuum is applied, and sample from an unknown volume of soil. Pan samplers only sample saturated flow. A capillary wick sampler was developed to overcome these problems. Materials for its construction were selected and tested for conductivity, capillary rise and chemical inertness. Breakthrough curves for selected inorganic ions and organic chemicals were established in the laboratory. No adsorption/desorption of these chemicals was found for the capillary wick sampler, the suction cup sampler, and the pan sampler. Banks of 8 capillary wick samplers were installed in test plots of undisturbed soils having sand, silt loam and clay textures. Bromide breakthrough curves were determined at each location. The data were used to determine the number of samplers required to characterize the flow of contaminants resulting from a uniform application to the soil surface. These results indicated that to achieve 95% confidence, 31 samplers would be required in the sandy soil, 6 in the silt loam soil and 2 in the clay soil. The experimental plots were drained and samples were collected over a range of soil moisture contents and soil moisture potentials. It was demonstrated that the wick sampler does adequately collect soil solution samples from soils having soil moisture potentials ranging from 0 to -0.0006 MPa. The capillary wick sampler is an improvement over existing samplers since it does not require continuous suction to provide continuous samples and because it can collect samples of flow which takes place when the soil is unsaturated. While the sampler collects volumes representative of the flux at potentials of 0.0005 MPa, convergence at greater potentials and divergence at lower potentials prevent its use as a tool for measuring flux of water or contaminants. (Author's abstract)
W90-05556

MONITORING FOR VOLATILE ORGANICS IN EFFERVESCENT GROUND WATER.

Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5A.
W90-05581

GROUND-WATER MONITORING COMPLIANCE PROJECT FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988.

Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W90-05585

ESTIMATION OF RAINFALL FOR FLOOD FORECASTING USING RADAR AND RAIN GAGE DATA.

Hydrologic Engineering Center, Davis, CA. W. J. Charley.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 802. Price codes: A03 in paper copy, A01 in microfiche. Technical Paper No. 122, September 1988. 6p, 3 fig, 10 ref.

Descriptors: *Remote sensing, *Radar, *Flood forecasting, *Rain gages, *Rainfall, Computer programs, Rain, Data interpretation, Reservoir operation, Kriging.

An inadequate knowledge of the magnitude and spatial distribution of precipitation is often a major limitation in developing accurate river flow forecasts for use in reservoir operations. Digitized weather radar data can provide useful information regarding the spatial distribution of rainfall, although radar-based estimates of rainfall may be in error due to several factors. The use of radar-rainfall data in combination with rain gage measurements may improve rainfall estimates over those based on either form of measurement alone. This improvement is accomplished by adjusting, or 'calibrating', radar-rainfall data with data from rain gages situated within the radar 'boundary'. A set of rainfall analysis software that incorporates this methodology has been developed to aid hydrologists in making real-time water control decisions. The rainfall analysis software retrieves real-time

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radar-rainfall data from a National Weather Service RADAP II (Radar Data Processor), and rain gage measurements from data collection platforms via the Geostationary Operational Environmental Satellite (GOES). The radar data from the RADAP II is calibrated with the rain gage data using a simple Kriging technique. Subbasin-average rainfall is then computed from the calibrated data and stored in a database file for subsequent use by a river flow forecast model. Graphics programs aid in the evaluation of the data. This software system has been implemented for a few pilot watersheds in Oklahoma. (Author's abstract) W90-05589

PEAK-FLOW DATA-COLLECTION METHODS FOR STREAMS IN ARID AREAS.

Geological Survey, Reston, VA. Water Resources Div.
E. D. Cobb.
IN: Transportation Research Record 1201, 1988, p 30-36, 6 fig, 8 ref.

Descriptors: *Stream gages, *Instrumentation, *Flood peak, *Data acquisition, *Arid lands, *Streamflow, *Channel flow, *Flow profiles, *Ephemeral streams, *Measuring instruments, *Stream stabilization, *Streambeds.

Methods of determining peak streamflows in arid areas, where unstable channels and ephemeral flows characterize many streams were developed. Usually, flow is determined from a recorded stage and a relational curve of stage and discharge. In unstable channels, it may be difficult to obtain a peak stage because the flow may move horizontally away from the gage, or the sediment in the flow may bury the stage sensor. If the peak stage is measured, the flow may be difficult to determine because of the unstable rating. As a result, the peak flow determination for streams with unstable channels commonly has a high degree of uncertainty. Stilling wells and bubble gage-manometer systems are most commonly used for obtaining measurements of stream stage. The heavy sediment loads transported by many arid area streams can fill a stilling well with sediment or bury intakes and orifices. For this reason, gages that do not have to be in the water, such as the ultrasonic ranger, are sometimes used to measure stream stage. Commonly, stream discharge is determined from a stage-discharge relation. In streams with severely unstable channels, such a relation does not exist. In such situations, it may be more appropriate to relate discharge to the depth of flow. A measure of the depth of flow can be obtained by measuring the stage of the water surface and the stage of the streambed. Streambed stabilization is sometimes possible on small-sized and medium-sized streams. Usually, because of the large sediment load transported through the stream system, it is not practical to totally stabilize the channel in the area to be gaged. A dual weir is useful in providing a fairly stable stage-discharge relation in some streams. Discharge measurements may be more complex on sand-channel streams with dunes and scour holes than on other streams. This is partly because the vertical-velocity curve is not normal, and additional velocity observations may be needed. Many arid-area streams are ephemeral and flashy, making it difficult to obtain discharge measurements. Dry stream channels near bridges commonly are disturbed by maintenance crews; this alters stage-discharge relations. Many factors, such as shifting stream channels and buried sensors, increase the uncertainty in the measurement of stage and discharge in streams in arid areas. However, techniques and instruments such as the ultrasonic ranger and the scour meter have been developed to reduce these uncertainties. (Lantz-PTT) W90-05596

QUALITY-ASSURANCE DATA FOR ROUTINE WATER ANALYSIS IN THE NATIONAL WATER-QUALITY LABORATORY OF THE U.S. GEOLOGICAL SURVEY FOR WATER YEAR 1988.

Geological Survey, Denver, CO. Water Resources Div.
K. J. Lucey.
Available from Books and Open Files Report Sec-

tion, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4166, 1989. 96p, 152 fig, 8 tab, 15 ref.

Descriptors: *Chemical analysis, *Data quality control, *Water analysis, Data collections, Standards, Inorganic compounds, Calcium, Fluorides, Iron, Magnesium, Manganese, Sodium, Potassium, Nitrates, Nitrites, Phosphorus, Ammonia.

The US Geological Survey maintains a quality assurance program based on the analysis of reference samples for its National Water Quality Laboratory located in Denver, Colorado. Reference samples containing selected inorganic, nutrient, and precipitation (low-level concentration) constituents are prepared at the Survey's Water Quality Services Unit in Ocala, Florida, disguised as routine samples, and sent daily or weekly, as appropriate, to the laboratory through other Survey offices. The results are stored permanently in the National Water Data Storage and Retrieval System (WATSTORE), the Survey's database for all water data. These data are analyzed statistically for precision and bias. An overall evaluation of the inorganic major ion and trace metal constituent data for water year 1988 indicated a lack of precision in the National Water Quality Laboratory for the determination of 8 out of 58 constituents: calcium (inductively coupled plasma emission spectrometry), fluoride, iron (atomic absorption spectrometry), iron (total recoverable), magnesium (atomic absorption spectrometry), manganese (total recoverable), potassium, and sodium (inductively coupled plasma emission spectrometry). The results for 31 constituents had positive or negative bias during water year 1988. A lack of precision was indicated in the determination of three of the six nutrient constituents: nitrate plus nitrite nitrogen as nitrogen, nitrite nitrogen as nitrogen, and orthophosphate as phosphorus. A biased condition was indicated in the determination of ammonia nitrogen as nitrogen, ammonia plus organic nitrogen as nitrogen, and nitrate plus nitrite nitrogen as nitrogen. There was acceptable precision in the determination of all 10 constituents contained in precipitation samples. Results for ammonia nitrogen as nitrogen, sodium, and fluoride indicated a biased condition. (Author's abstract) W90-05607

EVALUATION OF METHODS USED FROM 1965 THROUGH 1982 TO DETERMINE INORGANIC CONSTITUENTS IN WATER SAMPLES.

L. C. Friedman, and M. J. Fishman.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2293, 1989. 126p, 83 fig, 27 ref.

Descriptors: *Data quality control, *Pollutant identification, *Inorganic compounds, *Chemical analysis, *Water analysis, Colorimetry, Atomic absorption spectrophotometry, Spectrometry, Voltammetry, Quality control, Comparison studies.

Since 1962, the US Geological Survey has prepared and distributed Standard Reference Water Samples (SRWS) to participating laboratories in order to alert them to possible analytical deficiencies. This report marks the first time that a concentrated effort has been made to examine and compare the SRWS data for each constituent by the analytical method that was used to obtain the data. Unlike laboratories that participate in interlaboratory studies that are designed to determine the precision and accuracy of a particular analytical method, laboratories that participate in the SRWS program are allowed to select the method used to analyze a reference sample and are requested to report the method used. Data for a particular method could not be compared with a 'true' value because the data were obtained from analyses of reference samples that were prepared using natural waters; however, where possible a comparison was made between the mean concentrations obtained by the various analytical methods (i.e., colorimetry, atomic absorption spectrometry, atomic emission spectrometry, and voltammetry) that were used to determine each constituent. Where enough information is available, models for predicting the

precisions of the methods have been developed, and the precisions have been compared. In addition to the data presented in the reports, this evaluation provides a good indication of methods that were used routinely to analyze water samples during the 18 years of study. (Author's abstract) W90-05619

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CALIBRATION OF A GENERAL OPTICAL EQUATION FOR REMOTE SENSING OF SUSPENDED SEDIMENTS IN A MODERATELY TURBID ESTUARY.

National Environmental Satellite, Data, and Information Service, Washington, DC.
R. P. Stumpf, and J. R. Pennock.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 10, p 14,363-14,371, October 15 1989. 7 fig, 4 tab, 35 ref. NSF grant OCE-8601616.

Descriptors: *Estuaries, *Suspended sediments, *Remote sensing, *Sediment transport, Sediment concentration, Bed load, Algorithms, Mathematical studies, Mathematical equations, Calibrations, Bottom sediments.

A general algorithm for determining suspended sediment concentrations in the surface waters of estuaries has been developed for use with satellite data. The algorithm uses a three-parameter general optical equation to relate suspended sediment concentrations to water reflectances that have been corrected for sun angle effects, atmospheric path radiance, and tidal excursion. Using data collected by the advanced very high resolution radiometer on five different dates, reflectances were determined using two different methods, one providing maximum correction for haze and the other providing minimum sensitivity to pigments. For both methods, in situ and remotely sensed samples from Delaware Bay acquired within 3.5 h of each other agreed to within 60% at the 95% confidence level. Pixel and subpixel scale spatial variations and variability associated with in situ measurements produced about 50% of the differences. Chlorophyll concentrations of > 50 micrograms/L produced a discrepancy in the reflectance method that provided the best haze correction. The parameter values may be adjusted to allow for variations in sediment size and pigment variations, allowing application of the calibration to estuaries having optically different suspended sediments. (Author's abstract) W90-04566

DATA INTERPRETATION AND NUMERICAL MODELING OF THE MUD AND SUSPENDED SEDIMENT EXPERIMENT 1985.

Hanover Univ. (Germany, F.R.). Inst. fuer Stromeungsmechanik und Elektronisches Rechnen im Bauwesen.
For primary bibliographic entry see Field 2J.
W90-04568

MODELING THE EFFECT OF SUSPENDED SEDIMENT STRATIFICATION ON BOTTOM EXCHANGE PROCESSES.

Florida Univ., Gainesville. Coastal and Oceanographic Engineering Lab.
For primary bibliographic entry see Field 2J.
W90-04572

ENGINEERS AND OPERATORS NETWORK.

P. S. Hendricks.
Water Engineering and Management WENMD2, Vol. 136, No. 6, p 36-38, June 1989.

Descriptors: *Computers, *Networks, *Wastewater management, *Wastewater facilities, *Information systems, Computer programs, Information retrieval, Network design, Information exchange, Arizona.

Computer networking allows the exchange of drawings, the exchange of data on infrastructure

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changes and the exchange of process control data among wastewater treatment plants in an area or between plants and a central engineering or central operation. Metropolitan Area Networks have been made possible by the recent convergence of emerging computer technology and forces in the marketplace that demanded more of hardware and software. Networked, open architectures can lower the cost of business operations, improve the quality of operations, and provide timely information exchange for inter-agency and operational coordination. The entire 23rd Avenue treatment plant in Phoenix, Arizona, which has a 53-mgd capacity, will be controlled by a Johnson Controls JC-5000 System based on a networked, open architecture with adherence to IEEE communication standards. The other major facility in Phoenix that will be using a computer network is the 91st Avenue wastewater treatment plant, which has a 120-mgd capacity and has been expanded to a 153-mgd capacity. Johnson Controls JC-5000 System is going to be expanded to provide complete advanced process control throughout the facility. (Friedmann-PTT)
W90-04577

ACID DEPOSITION MODELING AND THE INTERPRETATION OF THE UNITED KINGDOM SECONDARY PRECIPITATION NETWORK DATA.
Hull Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-04579

GENERALIZED MULTIDIMENSIONAL MODEL FOR PRECIPITATION SCAVENGING AND ATMOSPHERIC CHEMISTRY.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-04580

MODELING OF ATMOSPHERIC TRANSPORT AND DEPOSITION OF TOXAPHENE INTO THE GREAT LAKES ECOSYSTEM.
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W90-04581

INTERCOMPARISON OF LONG-TERM ATMOSPHERIC TRANSPORT MODELS; THE BUDGETS OF ACIDIFYING SPECIES FOR THE NETHERLANDS.
UKAEA Atomic Energy Research Establishment, Harwell (England). Environmental and Medical Sciences Div.
For primary bibliographic entry see Field 5B.
W90-04582

FOAM RUBBER MODELING OF TOPOGRAPHIC AND DAM INTERACTION EFFECTS AT PACOIMA DAM.
Nevada Univ., Reno. Seismological Lab.
A. Anoshchepov, and J. N. Brune.
Bulletin of the Seismological Society of America BSSAAP, Vol. 79, No. 5, p 1347-1360, October 1989. 10 fig, 11 ref. Electric Power Research Institute grant EPRI RP-2556-2.

Descriptors: *Model studies, *Dams, *Hydraulic structures, *Seismic properties, *Dam stability, Topography, Hydraulic design, Dam design.

A study of the topographic and dam interaction effects was made using a 3-D foam rubber model of the actual topography around the Pacoima Dam accelerometer which recorded over 1 g high-frequency horizontal ground accelerations during the 1971 San Fernando earthquake. Scaling of frequency from the model to the earth depends on the average value of shear-wave velocity in the upper few hundred meters. Assuming beta sub e = 2 km/sec, for vertically incident SH waves, the spectral ratio of the ground acceleration on the ridge to the free field (flat surface) indicates an amplification of about 60% around 6.5 Hz on the N76 degrees W component. Topography has little effect upon the motion recorded on the S14 degrees W compo-

nent. Motion on the ridge is lower than the free-field motion on both horizontal components for frequencies above 9 Hz. Amplification peaks shift to higher or lower frequencies depending on the assumed shear-wave velocity in the upper few hundred meters. Results from nonvertically incident SH waves show that the topographic effect is dependent on the direction of approach of the seismic energy. The effect is either de-amplification (in part by shadowing) or amplification (relative to the case where no topography is present), depending on whether the canyon is on the ray path or not. The Fourier spectrum of the ground motion at the dam crest shows peak frequencies at about 5 Hz and 10 Hz (resonance), which correspond to the normal modes of the dam. A study of dynamic interaction between the Pacoima Dam and the ridge shows that the coupling is < 2% at about 10 Hz and < 12% at about 5 Hz. (Author's abstract)
W90-04583

OBSERVATIONS AND NUMERICAL SIMULATIONS OF PRECIPITATION DEVELOPMENT IN SEEDED CLOUDS OVER THE SIERRA NEVADA.
Wyoming Univ., Laramie.
N. Prasad, A. R. Rodi, and A. J. Heymsfield.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 10, p 1031-1049, 1989. 19 fig, 9 tab, 32 ref, append.

Descriptors: *Numerical analysis, Mathematical models, *Cloud seeding, *Convective precipitation, *Clouds, *Atmospheric physics, *Air circulation, *Cloud liquid water, Precipitation, Rainfall, Rain, Atmospheric water.

The evolution of precipitation in seeded winter-time orographically induced convective and stratiform clouds with embedded convection were studied using in situ observations and particle growth and trajectory models. The particle growth model of Heymsfield embedded in a kinematic flow field representative of the Sierra barrier was used to study the ice particle growth by diffusion, accretion and subsequent fall trajectories. The particles observed by the aircraft were classified into habits. The growth of observed particles were compared with the model predicted evolution. Using the aggregation model of Heymsfield, the observation of formation of aggregates in < 10 min. was verified. The key findings of this study were: (1) Aggregates (> 1 mm) form in 4-8 minutes after seeding a convective cloud. (2) Riming is important close to the barrier in a stratiform cloud when large cloud droplets and liquid water up to 0.3 g/cu m are present. (3) Diffusional growth is extremely important for temperatures near minus 15 C in these low liquid water content clouds. The particles grow to about 2 mm when released from just colder than minus 15 C, and to about 1 mm when falling from warmer than minus 15 C. (Author's abstract)
W90-04599

MESO-GAMMA-SCALE DISTRIBUTION OF OROGRAPHIC PRECIPITATION: NUMERICAL STUDY AND COMPARISON WITH PRECIPITATION DERIVED FROM RADAR MEASUREMENTS.
Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
For primary bibliographic entry see Field 2B.
W90-04602

ESTIMATION OF AREAL RAINFALL USING THE RADAR ECHO AREA TIME INTEGRAL.
National Severe Storms Lab., Norman, OK.
For primary bibliographic entry see Field 2B.
W90-04603

EFFECTS OF DIFFERENT RAIN PARAMETERIZATIONS ON THE SIMULATION OF MESOSCALE OROGRAPHIC PRECIPITATION.
Observatoire de Physique du Globe de Clermont-Ferrand (France).
For primary bibliographic entry see Field 2B.

W90-04605

CHARACTERISTICS OF MESOSCALE PRECIPITATION BANDS IN SOUTHERN FINLAND.
Helsinki Univ. (Finland). Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W90-04612

APPLICATION OF FRACTAL MATHEMATICS TO SOIL WATER RETENTION ESTIMATION.
Nevada Univ., Las Vegas. Desert Research Inst.
S. W. Tyler, and W. W. Wheatcraft.
Soil Science Society of America Journal SSSJDA, Vol. 53, No. 4, p 987-996, July/August 1989. 15 fig, 2 tab, 19 ref. DOE grant DE-FG08-85-NV10461.

Descriptors: *Soil water, *Soil physical properties, *Model studies, *Fractal mathematics, *Soil moisture retention, *Soil water potential, Mathematical studies, Soil porosity.

An analysis was performed to correlate the fitting parameter in an earlier soil water retention model to physical properties of the soil. Fractal mathematics were used to show that the parameter is equal to the fractal dimension of the pore trace and expresses a measure of the tortuosity of the pore trace. The fractal dimension of the particle-size distribution can be easily measured and related to the fitting parameter of the earlier model. By suggesting a physical significance of the coefficient, the universality of the model is greatly improved. Soil water retention data, estimated strictly from particle-size distributions, were proven to match measured data quite well. The fractal dimension of pore traces ranges from 1.011 to 1.485 for all but one soil tested. (Author's abstract)
W90-04614

MODELING THE TRANSPORT OF CHROMIUM (VI) IN SOIL COLUMNS.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-04615

SIMULATION OF SOIL WATER ABOVE A WATER TABLE IN A FORESTED SPodosol.
International Paper Co., Arkadelphia, AR.
For primary bibliographic entry see Field 2G.
W90-04628

ANALYTIC TECHNIQUE FOR STOCHASTIC ANALYSIS IN ENVIRONMENTAL MODELS.
Alaska Univ., Fairbanks. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04659

SPATIAL INTERRELATIONSHIPS BETWEEN TERRAIN, SNOW DISTRIBUTION AND VEGETATION PATTERNS AT AN ARCTIC FOOT-HILLS SITE IN ALASKA.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 2A.
W90-04714

TIDAL MODELLING OF DAPENG BAY, CHINA.
Zhongshan Univ., Guangzhou (China).
For primary bibliographic entry see Field 2L.
W90-04722

SPRAT-A SIMPLE RIVER QUALITY IMPACT MODEL FOR INTERMITTENT DISCHARGES.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
For primary bibliographic entry see Field 5C.
W90-04773

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MODELLING OF POLLUTION LOADS FROM COMBINED SEWER SYSTEMS TO RECEIVING WATERS.
PH-Consult ApS, Gentofte (Denmark).
For primary bibliographic entry see Field 5B.
W90-04774

PROBABILISTIC RELIABILITY ANALYSIS FOR BIOLOGICAL WASTEWATER TREATMENT PLANTS.
Artois-Picardie Water Agency, Douai (France).
For primary bibliographic entry see Field 5D.
W90-04778

DEVELOPMENT OF AN OPERATIONAL TWO-DIMENSIONAL WATER QUALITY MODEL FOR LAKE MARKEN, THE NETHERLANDS.
Rijksdienst voor de IJsselmeerpolders, Lelystad (Netherlands).
For primary bibliographic entry see Field 2H.
W90-04779

DEVELOPMENT OF DIALOG SYSTEM MODEL FOR EUTROPHICATION CONTROL BETWEEN DISCHARGING RIVER BASIN AND RECEIVING WATER BODY - CASE STUDY OF LAKE SAGAMI (JAPAN).
Tokyo Univ. (Japan). Inst. of Industrial Science.
For primary bibliographic entry see Field 5G.
W90-04780

ROLE OF SKIN ABSORPTION AS A ROUTE OF EXPOSURE TO VOLATILE ORGANIC COMPOUNDS IN HOUSEHOLD TAP WATER: A SIMULATED KINETIC APPROACH.
Clark Univ., Worcester, MA. Center for Technology, Environment, and Development.
For primary bibliographic entry see Field 5B.
W90-04831

APPROXIMATE ALGEBRAIC SOLUTION FOR A BIOFILM MODEL WITH THE MONOD KINETIC EXPRESSION.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5D.
W90-04836

EFFECT OF REACTOR HYDRAULICS ON THE PERFORMANCE OF ACTIVATED SLUDGE SYSTEMS: I. THE TRADITIONAL MODELLING APPROACH.
Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-04839

EFFECT OF REACTOR HYDRAULICS ON THE PERFORMANCE OF ACTIVATED SLUDGE SYSTEMS: II. THE FORMATION OF MICROBIAL PRODUCTS.
Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-04840

SIMPLE, CONCEPTUAL MATHEMATICAL MODEL FOR THE ACTIVATED SLUDGE PROCESS AND ITS VARIANTS.
North Carolina State Univ. at Raleigh. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W90-04842

WHITE CART WATER FLOOD ALLEVIATION STUDY USING HYDRODYNAMIC MATHEMATICAL-MODELLING TECHNIQUES.
For primary bibliographic entry see Field 2E.
W90-04909

FIVE-YEAR RADAR CLIMATOLOGY OF CONVECTIVE PRECIPITATION FOR NEW JERSEY.

New Jersey Agricultural Experiment Station, New Brunswick.
For primary bibliographic entry see Field 2B.
W90-04996

FURTHER RESEARCH ON APPLICATION OF PROBABILITY WEIGHTED MOMENTS IN ESTIMATING PARAMETERS OF THE PEARSON TYPE THREE DISTRIBUTION.
Chengdu Univ. of Science and Technology (China).
J. Ding, D. Song, and R. Yang.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 239-257, October 1989. 13 fig, 3 tab, 8 ref, 5 append.

Descriptors: *Flood forecasting, *Statistics, *Statistical analysis, *Reservoirs, *Mathematical studies, Probabilistic process, Floods, Project planning, Water level fluctuations, Mathematical models, Parameter estimation.

A recently developed method for estimating parameters of P-III distribution by using probability weighted moments (PWM) is presented. The computing procedure was largely simplified with the PWM method which was appropriate and functional for various conditions of the skewness coefficient. Statistical experiments based on the new procedure showed that PWM estimators are almost unbiased and compare favorably with those by the conventional moment method. The new table makes it possible to extend this method for engineering practice. The estimators were applied for real flood data at 11 of 59 previously analyzed stations in China and the results of the two methods are compared. The PWM method was also applied to estimating parameters of maximum annual water levels of reservoirs. (Author's abstract)
W90-05000

EXPRESSIONS RELATING PROBABILITY WEIGHTED MOMENTS TO PARAMETERS OF SEVERAL DISTRIBUTIONS INEXPRESSIBLE IN INVERSE FORM.
Chengdu Univ. of Science and Technology (China).
J. Ding, D. Song, R. Yang, and Y. Hou.
Journal of Hydrology JHYDA7, Vol. 110, No. 3/4, p 259-270, October 1989. 1 tab, 7 ref.

Descriptors: *Statistics, *Flood forecasting, *Probabilistic process, *Probability distribution, *Mathematical studies, *Mathematical models, Flooding, Project planning, Mathematical equations, Parameter estimation.

The probability weighted moment (PWM) method can generally be used in estimating parameters of a distribution whose inverse form cannot be expressed explicitly. For several distributions, such as normal, log-normal and Pearson Type Three distributions, the expressions relating PWM to parameters have the same forms. Some distributions expressible in inverse form, such as the Gumbel and Logistic distributions, have as their expressions the same forms as these distributions inexpressible in inverse forms. The PWM method might be promising for estimating the parameters of exponential gamma distribution which is more flexible and can better be fitted to flooding of rivers in both the north and south of China than the Pearson-III distribution and the distribution of Kritsky and Menkel. (Author's abstract)
W90-05001

GEOSTATISTICAL MODELLING OF THE WASIA AQUIFER IN CENTRAL SAUDI ARABIA.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Faculty of Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-05003

MODELING FOR CLASS-I SEDIMENTATION.
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-05026

BIOACTIVE ADSORBER MODEL FOR INDUSTRIAL WASTEWATER TREATMENT.
University of Southern California, Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-05029

MODEL ILLUSTRATING THE ENVIRONMENTAL FATE, EXPOSURE AND HUMAN UPTAKE OF PERSISTENT ORGANIC CHEMICALS.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 5B.
W90-05041

EXPOSURE AND ECOTOXICITY ESTIMATION FOR ENVIRONMENTAL CHEMICALS (E4CHEM): APPLICATION OF FATE MODELS FOR SURFACE WATER AND SOIL.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Umweltgefahrungs-sponsientiale von Chemikalien.
For primary bibliographic entry see Field 5B.
W90-05042

FAST GRAPHICAL SIMULATIONS OF SPILLS AND PLUMES FOR APPLICATION TO THE GREAT LAKES.
Guelph Univ. (Ontario). Dept. of Computing and Information Science.
For primary bibliographic entry see Field 5B.
W90-05044

STUDY ON SOLUTE NO3-N TRANSPORT IN THE HYDROLOGIC RESPONSE BY AN MRF MODEL.
Trento Univ. (Italy). Dept. of Engineering.
For primary bibliographic entry see Field 5B.
W90-05045

MODEL ANALYSIS OF SEAWATER INTRUSION INTO SATURATED AND UNSATURATED DOMAINS, (IN JAPANESE).
Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.
K. Inouchi, T. Kakinuma, and M. Sawa.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 3, p 207-217, 1989. 12 fig, 2 tab, 18 ref. English summary.

Descriptors: *Saline water intrusion, *Surface-groundwater relations, *Geohydrology, *Saline groundwater, Model studies, Hydrodynamic dispersion, Finite element method.

The phenomena of seawater intrusion into phreatic aquifers is examined by using a hydrodynamic dispersion model in both saturated and unsaturated domains. The numerical solutions are obtained by the finite-element method for various dispersion coefficients/dispersivities and precipitation intensities. The main results are as follows: (1) In the steady state analysis, as the value of dispersion coefficient/dispersivity gets smaller, the pattern of concentration distribution in the saturated domain changes from the strong mixing type to the moderate mixing type and a circulating current develops near the outlet of the aquifer. For relatively small dispersion coefficients/dispersivities, the degree of seawater intrusion predicted by the dispersion model agrees well with that by the fresh-salt water interface model; and (2) In the unsteady state analysis, the movement of isoconcentrations of concentration induced by a sudden change in precipitation intensity is faster in retreating than in advancing, and the smaller the value the isoconcentration is, the more slowly the isoconcentration moves both in retreating and in advancing. (Author's abstract)
W90-05053

SIMULATION OF THE RATE-CONTROLLED TRANSPORT OF MOLYBDATE IN COLUMN EXPERIMENTS.
Geological Survey, Denver, CO.

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For primary bibliographic entry see Field 5B.
W90-05076

METHODS OF EVALUATING THE RELATION OF GROUND-WATER QUALITY TO LAND USE IN A NEW JERSEY COASTAL PLAIN AQUIFER SYSTEM.

Geological Survey, West Trenton, NJ.
For primary bibliographic entry see Field 5A.
W90-05105

PLANNED STUDIES OF HERBICIDES IN GROUND AND SURFACE WATER IN THE MID CONTINENTAL UNITED STATES.

Geological Survey, Iowa City, IA.
For primary bibliographic entry see Field 5B.
W90-05108

USE OF A SIMPLIFIED TRANSPORT MODEL FOR PESTICIDES IN THE UNSATURATED ZONE.

Geological Survey, Richmond, VA.
For primary bibliographic entry see Field 5B.
W90-05116

METHOD FOR SIMULATING WATER-TABLE ALTITUDES FROM STREAM AND DRAINAGE-BASIN LOCATIONS BY USE OF A GEOGRAPHIC INFORMATION SYSTEM.

Geological Survey, West Trenton, NJ.
W. A. Battaglin, R. L. Ulery, and E. R. Vowinkel.
IN: U.S. Geological Survey Toxic Substances Hydrology Program: Proceedings of the Technical Meeting, Phoenix, Arizona, September 26-30, 1988. USGS Water-Resources Investigations Report 88-4220, 1989. p531-539, 5 ref.

Descriptors: *Water table, *Watersheds, *Mapping, Streams, Drainage divides, Hydraulic divides, Geographic information systems, Altitude, Dupuit-Forchheimer equation, Simulation studies.

A method was developed that uses a Geographic Information System to simulate water levels in an unstressed water table for a 7.5-minute quadrangle. The Dupuit-Forchheimer equation was solved for water-table altitude at 1,698 nodes on a grid over the study area. Input data consists of locations and altitudes of streams, locations of drainage divides, and estimates of aquifer hydraulic conductivity and recharge rate. The Geographic Information System calculated altitudes of streams at discrete intervals between points of known altitude, distances between each node and the nearest drainage divide, and distances between each node and the nearest stream. Results were contoured and displayed with Geographic Information System software. Measured water-table altitudes at 22 wells are compared with simulated water-table altitudes at those points. The median of the absolute value of the residuals for this comparison is 6.2 ft; the first and third quartiles are 2.1 and 8.0 ft, respectively. The medium percentage error at the 22 locations is 7.6%. (See also W90-05059) (Author's abstract)
W90-05117

SIMULATION OF GROUND- AND SURFACE-WATER FLOW IN THE GLOBE AREA, ARIZONA.

Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 5B.
W90-05122

MODELING CONTAMINANT TRANSPORT IN GROUNDWATER: APPROACHES, CURRENT STATUS, AND NEEDS FOR FURTHER RESEARCH AND DEVELOPMENT.

Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 5B.
W90-05180

FLOOD INUNDATION MODELLING USING MILHY.

European Research Office, London (England).

For primary bibliographic entry see Field 2E.
W90-05181

FLOOD BOUNDARIES AND WATER-SURFACE PROFILE FOR THE COMPUTED 100-YEAR FLOOD, SWIFT CREEK AT AFTON, WYOMING, 1986.

Geological Survey, Cheyenne, WY. Water Resources Div.
J. G. Rankl, and J. C. Wallace.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4064, 1989. 2 (map) sheets, 4 fig, 1 tab, 7 ref.

Descriptors: *Maps, *Floods, *Flood flow, *Flood frequency, *Flood peak, *Flood profiles, *Flood maps, *Wyoming, Open-channel flow, Bridges, Culverts, Dams, Swift Creek.

This map describes the analysis of flood flows on Swift Creek at Afton, Wyoming, and shows flood boundaries and inundated areas, the elevation of the water surface for a theoretical 100-year flood on 23 cross sections, and a water surface profile through the study reach. A 3.2 mile reach of Swift Creek was considered in the analysis. The elevation of the 100-year flood was computed using a water surface profile model for open-channel flow and flow through bridges. Elevations of the 100-year flood for flow through culverts and over a dam were computed using standard hydraulic methods. The 100-year flood discharge was computed using 37 years of peak-flow data collected at a U.S. Geological Survey streamflow-gaging station at the upstream end of the study reach. The theoretical 100-year flood discharge was computed to be 902 cu ft/sec. The largest recorded flood discharge on Swift Creek, 793 cu ft/sec, occurred on July 6, 1975. (USGS)
W90-05192

GROUND-WATER AND SURFACE-WATER DATA FOR WASHINGTON COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.
Available from Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218. Basic Data Report No. 18, 1989. 273p, 40 fig, 21 tab, 10 ref. Compiled by M. T. Duigon, J. R. Dine, and M. D. Tompkins.

Descriptors: *Data collections, *Groundwater, *Surface water, *Water quality, *Well data, *Water resources data, *Gaging stations, *Maryland, Aquifers, Bottom sediments, Environmental quality, Groundwater level, Observation wells, Pesticide residues, Potentiometric level, Streams, Trace elements, Water table.

Hydrologic data for Washington County, Maryland, are presented. Locations and descriptions of more than 2,500 wells and 262 springs are provided, along with water levels measured in 50 wells, geophysical logs of 11 wells, and chemical analyses of 267 wells and springs. Surface water information includes drainage-basin characteristics for 34 sites along 30 streams, amounts of streamflow, chemical analyses of water and stream-bottom materials, and sediment-load and particle-size data. Water-appropriation data for groundwater and surface-water sources also are presented. (USGS)
W90-05207

WATER QUALITY OF LAKE AUSTIN AND TOWN LAKE, AUSTIN, TEXAS.

Geological Survey, Austin, TX. Water Resources Div.
F. L. Andrews, F. C. Wells, W. J. Shelby, and E. M. McPherson.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4233, 1988. 322p, 38 fig, 59 tab, 18 ref.

Descriptors: *Limnology, *Water pollution sources, *Texas, *Water quality, *Storm runoff, Dissolved oxygen, Trace elements, Nitrogen, Phosphorus, Dissolved solids, Bacteria.

Lake Austin and Town Lake are impoundments on the Colorado River in Travis County, central Texas, and are a source of water for municipal and industrial water supplies, electrical-power generation, and recreation for more than 500,000 people in the Austin metropolitan area. Small vertical temperature variations in both lakes were attributed to shallow depths in the lakes and short retention times of water in the lakes during the summer months. The largest areal variations in dissolved oxygen generally occur in Lake Austin during the summer as a result of releases of water from below the thermocline in Lake Travis. Except for iron, manganese, and mercury, dissolved concentrations of trace elements in water collected from Lake Austin and Town Lake did not exceed the primary or secondary drinking water standards set by the U.S. Environmental Protection Agency. Little or no effect of storm-water runoff on temperature, dissolved oxygen, or minor elements could be detected in either Lake Austin or Town Lake. Little seasonal or areal variation was noted in nitrogen concentrations in Lake Austin or Town Lake. Total phosphorus concentrations generally were small in both lakes. Increased concentrations of nitrogen and phosphorus were detected after storm runoff inflow in Town Lake, but not in Lake Austin; densities of fecal-coliform bacteria increased in Lake Austin and Town Lake, but were substantially greater in Town Lake than in Lake Austin. (USGS)
W90-05212

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN TEXAS-FISCAL YEAR 1988.

Geological Survey, Austin, TX. Water Resources Div.
A. A. Mitchell.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225; price codes. USGS Open-File Report 89-73, 1989. 81p, 1 fig, 1 plate, 1 tab.

Descriptors: *Texas, *Water resources data, *Hydrologic data, *Groundwater, *Surface water, *Water quality, *Data collections.

This report describes the activities of the U.S. Geological Survey Water Resources Division in Texas for fiscal year 1988. The project number, cooperating agencies, project chief, period of project, location, problem, objective, approach, progress, reports in preparation, and reports published are given for each project in the Texas District. The report also includes a list of reports published or approved for publication during fiscal year 1988, and a plate showing the locations of the Subdistrict areas and active surface-water stations in Texas. (USGS)
W90-05213

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN WYOMING, FISCAL YEARS 1988-89.

Geological Survey, Cheyenne, WY. Water Resources Div.
D. M. Oden.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225; price codes. USGS Open-File Report 89-262, 1989. 124p, 6 fig, 9 tab. USGS Project WY888.

Descriptors: *Wyoming, *Data collections, *Hydrologic data, *Streamflow, *Water quality, *Groundwater, Water supply, Environmental effects, Hydrology, Sediment load.

There are two types of water-resources activities of the U.S. Geological Survey in Wyoming: collection of hydrologic data, and water-resources-appraisal projects. During Fiscal Years 1988 and 1989, the work was done in cooperation with 10 State agencies, 5 counties, 3 cities, 2 towns, 1 irrigation district, 2 Indian Tribes, and 8 Federal agencies. Lists and location maps are included for 180 streamflow stations, 16 reservoir stations, 120 surface-water-quality stations, 15 sediment stations, 88 groundwater-level observation wells, and 73 groundwater quality sites, which were in operation

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during Fiscal Year 1988 and (or) Fiscal Year 1989. During Fiscal Years 1987 and 1988, 17 streamflow stations, 13 surface-water-quality stations, 14 sediment stations, and 7 groundwater level observation wells were discontinued. During Fiscal Year 1988 and through the first quarter of Fiscal Year 1989, 21 streamflow stations, 15 surface-water-quality stations, and 3 sediment stations were established or reactivated. Descriptions, location maps, and progress statements are given for 4 data collection projects and 27 water resources-appraisal projects that were active during Fiscal Year 1988 and (or) Fiscal Year 1989. Eleven projects were completed during Fiscal Year 1988 or 1989 and 10 projects that were completed except for the project reports. Also included is a bibliography of reports by U.S. Geological Survey authors about the water resources of Wyoming. (USGS) W90-05214

COMPILATION OF GEOHYDROLOGIC DATA COLLECTED AS PART OF THE AREAL APPRAISAL OF GROUND-WATER RESOURCES NEAR BRANSON, MISSOURI.

Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-401, Oct. 1989. 24p, 6 fig, 5 tab, 4 ref.

Descriptors: *Groundwater, *Water use, *Water demand, *Data collections, *Water quality, *Missouri, White River, Water use.

A rapidly developing retirement community and tourist industry in the Branson, Missouri area has created an increased demand for potable water, especially in the summer months. The rapid pace of residential and business expansion has created concerns regarding the future groundwater availability and quality. Water levels measured in the Ozark aquifer during the summer of 1988 and March 1989 show water levels increasing in 22 wells, decreasing in 2 wells, and remaining the same in 1 well. The water level increases ranged from 1 to 111 ft. These measurements and similar measurements during the summer of 1989 will be used to calibrate a three-dimensional model of groundwater flow in the Branson area and estimate the long-term effect of large groundwater withdrawals during the summer tourist season. A reconnaissance of water quality in 34 wells that are open to the Ozark aquifer shows specific conductance ranging from 347 to 841 microsiemens/cm at 25 C and no fecal coliform bacteria present in any well. Chloride and nitrate concentrations in all wells were well below the Missouri Department of Natural Resources recommended maximum concentrations of 250 mg/L and 10 mg/L, respectively. Analysis of 5 water samples for 33 volatile organic compounds failed to detect any concentrations in excess of the detection limits. (USGS) W90-05216

INDEXES OF HYDROLOGIC DATA FROM SELECTED COAL-MINING AREAS IN NORTH-WESTERN COLORADO.

Geological Survey, Denver, CO. Water Resources Div.
N. G. Gaggiani.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-347, October 1989. 30p, 3 plates, 2 fig, 8 tab.

Descriptors: *Data collections, *Databases, *Colorado, *Hydrologic data, *Computers, *Data processing, Water quality, Water level, Groundwater, Surface water.

Currently (1988), data from hydrologic studies related to coal mining that have been done in northwestern Colorado since the early 1970's are stored in the files of private companies and government offices and in various computer systems. To compile these data for additional research, a trip to each office would have to be made to determine the availability and acceptability of the data. The U.S. Geological Survey, in cooperation with the

U.S. Bureau of Land Management and the Colorado Mined Land Reclamation Division, has created a database (COALDATA) that includes stream discharge, groundwater levels, and chemical analysis of water samples that were collected by private companies and government agencies other than the U.S. Geological Survey and in near selected coal mines in northwestern Colorado. Indexes in this report list 93 surface water sites and 95 groundwater sites where hydrologic data are available in the COALDATA data base. The indexes also list 62 surface water sites and 480 groundwater sites in the U.S. Geological Survey data base, which is separate from the COALDATA data base and contains only data collected by the U.S. Geological Survey. The combined output of the COALDATA data base and the U.S. Geological Survey data base provides surface water and groundwater data that include most of the study area. (USGS) W90-05217

NUMERICAL SOLUTION FOR THE DIFFUSION EQUATION IN HYDROGEOLOGIC SYSTEMS.

Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-05222

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1985.

Geological Survey, Louisville, KY. Water Resources Div.
J. M. Bettendorf, C. J. Schlar, J. L. Smoot, and S. A. Toms.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-152674. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report WRD/HD-86/253, 1986. 342 p. Prepared in cooperation with the State of Kentucky and with other agencies.

Descriptors: *Kentucky, *Hydrologic data, *Data collections, *Surface water, *Water quality, *Groundwater, Gaging stations, Streamflow, Flow rates, Lakes, Wells, Chemical analysis, Suspended sediments, Water temperature, Water level.

Water resources data for the 1985 water year for Kentucky consist of records of stage, discharge, and water quality of streams; stage and water levels of wells. This report contains discharge records from 103 gaging stations; suspended-sediment data for 25 stations (8 daily); daily temperature records for 11 stations; daily specific conductance for 9 stations; ground-water levels for 9 continuous-record wells and 102 partial-records wells; water-quality data from 16 surface-water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 83 gaging stations. Also included are 84 partial-record crest-stage sites. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (USGS) W90-05235

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1984.

Geological Survey, Baton Rouge, LA. Water Resources Div.
D. D. Carlson, G. R. Stallworth, L. J. Dantin, and C. G. Stuart.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130366. Price codes: A99 in paper copy, A01 in microfiche. USGS Water-Data Report LA-84-1 (WRD/HD-85/258), 1984. 608 p. Prepared in cooperation with the State of Louisiana and with other agencies.

Descriptors: *Louisiana, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Louisiana consist of records of stage, discharge,

and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report, in one volume, contains records for water discharge at 72 gaging stations (including stage for 71 of these stations); stage only for 40 gaging stations and 11 lakes; water quality for 80 surface-water stations (including 26 gaging stations), 17 miscellaneous sites, 10 lakes, and 145 wells; and water levels for 423 observation wells. Also included are data for 141 crest-stage and flood-profile partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Louisiana. (USGS) W90-05236

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1984.

Geological Survey, Augusta, ME. Water Resources Div.
C. R. Haskell, W. P. Bartlett, W. B. Higgins, and W. J. Nichols.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-240265. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report ME-84-1 (WRD/HD-85-232), 1985. 144 p. Prepared in cooperation with the State of Maine and with other agencies.

Descriptors: *Maine, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Maine consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of wells. This report contains discharge records for 53 gaging stations; stage only for 2 gaging stations; contents for 17 lakes and reservoirs; water quality for 11 gaging stations; and water levels for 17 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies. (USGS) W90-05237

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1984.

Geological Survey, Towson, MD. Water Resources Div.
R. W. James, R. H. Simmons, and B. F. Strain.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-936314. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report MD-DE-84-1 (WRD/HD-85/236), 1985. 321 p. Prepared in cooperation with the States of Maryland and Delaware and with other agencies.

Descriptors: *Maryland, *Delaware, *District of Columbia, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Maryland and Delaware consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 104 gaging stations; stage and contents at 1 reservoir; water quality at 17 gaging stations and 97 wells; and water levels at 24 observation wells. Also included are data for 12 crest-stage and 4 tidal crest-stage partial-record stations. Additional

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water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Maryland and Delaware. (USGS) W90-05238

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1985.

Geological Survey, Towson, MD. Water Resources Div.
R. W. James, R. H. Simmons, and B. F. Strain.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111878. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report MD-DE-85-1 (WRD/HD/86/245), 1986. 287 p. Prepared in cooperation with the States of Maryland and Delaware and with other agencies.

Descriptors: *Maryland, *Delaware, *District of Columbia, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Maryland and Delaware consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 101 gaging stations; stage and contents at 1 reservoir; water quality at 25 gaging stations and 123 wells; and water levels at 24 observation wells. Also included are data for 12 crest-stage, 11 low-flow, and 6 tidal crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Maryland and Delaware. (See also W90-05238) (USGS) W90-05239

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1983.

Geological Survey, Boston, MA. Water Resources Div.
R. A. Gadoury, G. G. Girouard, and K. G. Ries.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-215978. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report MA-RI-83-1 (WRD/HD-85/213), 1985. 237 p. Prepared in cooperation with the States of Massachusetts and Rhode Island and with other agencies.

Descriptors: *Massachusetts, *Rhode Island, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1983 water year for Massachusetts and Rhode Island consist of records of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 93 gaging stations, month-end contents for 30 lakes and reservoirs, water quality for 12 gaging stations, and water levels for 107 observation wells. Also included are data for 20 low-flow and 18 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. A few pertinent stations (not included above) in bordering States are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (USGS) W90-05240

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1984.

Geological Survey, Boston, MA. Water Resources Div.
R. A. Gadoury, G. G. Girouard, K. G. Ries, and H. L. White.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-105656. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report MA-RI-84-1 (WRD/HD-86/234), 1986. 212 p. Prepared in cooperation with the States of Massachusetts and Rhode Island and with other agencies.

Descriptors: *Massachusetts, *Rhode Island, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Massachusetts and Rhode Island consist of records of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 91 gaging stations, month-end contents for 30 lakes and reservoirs, water quality for 9 gaging stations, and water levels for 106 observation wells. Also included are data for 1 crest-stage partial-record station. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. A few pertinent stations (not included above) in bordering States are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (See also W90-05240) (USGS) W90-05241

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1985.

Geological Survey, Lansing, MI. Water Resources Div.
J. B. Miller, J. L. Oberg, and J. C. Failing.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-119954. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report MI-85-1 (WRD/HD-86-240), 1986. 297 p. Prepared in cooperation with the State of Michigan and with other agencies.

Descriptors: *Michigan, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Michigan consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water temperature of groundwater. This report contains discharge records for 135 gaging stations; stage only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water-quality records for 52 gaging stations; water-level records for 53 observation wells; and water-temperature records for 6 observation wells. Also included are 52 crest-stage partial-record stations and 30 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs. Miscellaneous data were collected at 41 measuring sites and 1 water-quality sampling site. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, Local, and Federal agencies in Michigan. (USGS) W90-05242

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.

Geological Survey, St. Paul, MN. Water Resources Div.

K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.

Available from the National Technical Information Service, Springfield, VA 22161, as PB85-215986. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report MN-83-1 (WRD/HD-85/214), 1985. 202 p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Minnesota, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1983 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 52 gaging stations; stage-only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water quality for 16 gaging stations, 1 stage station, 14 partial-record stations, and 18 wells; and water levels for 42 observation wells. Also included are 43 high-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data, together with the data in Volume 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-05244) (USGS) W90-05243

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1983. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASINS.

Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-215994. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report MN-83-2 (WRD/HD-85/215), 1984. 447 p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Minnesota, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1983 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 72 gaging stations; stage and contents for 11 lakes and reservoirs; water quality for 25 stream stations, 16 partial-record stations, 1 lake station, and 107 wells; and water levels for 238 observation wells. Also included are 107 high-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data, together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (USGS) W90-05244

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.

Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172524. Price codes: A19 in paper copy, A01 in microfiche.

Evaluation, Processing and Publication—Group 7C

USGS Water-Data Report MN-84-2 (WRD/HD-87/211), 1986. 417 p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Minnesota, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Precipitation, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 68 gaging stations; stage and contents for 11 lakes and reservoirs; water quality for 28 stream stations, 12 partial-record stations, 4 lake stations, and 175 wells; and water levels for 238 observation wells. Also included are 97 high-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data, together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-05243) (USGS) W90-05245

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1984.

Geological Survey, Jacksonville, FL. Water Resources Div.

E. J. Tharpe, F. Morris, and W. T. Oakley. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-105664. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report WRD/HD-86/219, 1986. 340 p. Prepared in cooperation with the State of Mississippi and with other agencies.

Descriptors: *Mississippi, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis.

Water resources data for the 1984 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records of water discharge at 67 gaging stations; stage records for 18 of these gaging stations; stage only at 5 gaging stations; water quality for 23 stations, 2 precipitation-quality stations, and 94 wells; and water levels for 315 observation wells. Also included are peak-discharge data for 89 crest-stage partial-record stations and water-quality data at 66 partial-record or miscellaneous sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Mississippi. (USGS) W90-05246

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1984.

Geological Survey, Rolla, MO. Water Resources Div.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-135324. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report MO-85-1 (WRD/HD-85/257), 1985. 329 p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: *Missouri, *Data collections, *Hydrologic data, *Surface water, *Water quality, Flow rates, Gaging stations, Streamflow, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Missouri consist of records of stage, discharge, and water quality of lakes and reservoirs; contains records for water discharge at 112 gaging stations; stage and contents at 9 lakes and reservoirs; water quality at 71 sampling stations (including 1 lake) and data for 35 crest-stage stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Missouri. (USGS) W90-05247

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1985.

Geological Survey, Rolla, MO. Water Resources Div.

L. A. Waite, J. V. Davis, H. L. Reed, T. J. Perkins, and D. O. Hatten. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-115598. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report MO-86-1 (WRD/HD-86/247), 1986. 325 p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: *Missouri, *Data collections, *Hydrologic data, *Surface water, *Water quality, Flow rates, Gaging stations, Streamflow, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Missouri consist of records of stage, discharge, and water quality of lakes and reservoirs; contains records for water discharge at 108 gaging stations, stage and contents at 9 lakes and reservoirs; water quality at 68 sampling stations (including 1 lake); and data for 20 crest-stage stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Missouri. (See also W90-05247) (USGS) W90-05248

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984, VOLUME 1, HUDSON BAY AND MISSOURI RIVER BASINS.

Geological Survey, Helena, MT. Water Resources Div.

R. R. Shields, J. R. Knapton, M. K. White, M. A. Jacobson, and M. L. Kasman. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-181633. Price codes: A99 in paper copy, A01 in microfiche. USGS Water-Data Report MT-84-1, 1985. 589 p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Montana, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. Volume 1 of this report contains discharge records for 204 gaging stations; stage only records for 1 lake station; stage/contents for 5 lakes and reservoirs; water quality for 87 stations; water levels for 12 observation wells. Also included are 138 crest-stage partial-record stations and 33 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. Specific conductance determinations are also published for

each discharge measurement made during the year. (See also W90-05250) (USGS) W90-05249

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1984, VOLUME 2, COLUMBIA RIVER BASIN.

Geological Survey, Helena, MT. Water Resources Div.

R. R. Shields, J. R. Knapton, M. K. White, M. A. Jacobson, and M. L. Kasman. Available from the National Technical Information Service, Springfield, VA 22161, as PB85-235984. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report MT-84-2 (WRD/HD-85/227), 1985. 169 p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Montana, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. Volume 2 of this report contains discharge records for 56 gaging stations; stage/contents for 3 lakes and reservoirs; water quality for 20 stations, 3 lakes; water levels for 10 observation wells. Also included are 31 crest-stage partial-record stations and 20 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (See also W90-05249) (USGS) W90-05250

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1985, VOLUME 1, HUDSON BAY AND MISSOURI RIVER BASINS.

Geological Survey, Helena, MT. Water Resources Div.

R. R. Shields, J. R. Knapton, M. K. White, T. M. Brosten, and M. L. Kasman. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-152658. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report MT-85-1 (WRD/HD-86/263), 1986. 483 p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Montana, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. Volume 1 of this report contains discharge records for 199 gaging stations; stage only records for 1 lake station; stage/contents for 5 lakes and reservoirs; water quality for 74 stations; water levels for 119 observation wells. Also included are 130 crest-stage partial-record stations and 33 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (See also W90-05249) (USGS) W90-05251

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1984.

Geological Survey, Lincoln, NE. Water Resources Div.

Field 7—RESOURCES DATA

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G. B. Engel, R. A. Engberg, and M. J. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-163052. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report NE-84-1 (WRD/HD-86/212), 1985. 383 p. Prepared in cooperation with the State of Nebraska and other agencies.

Descriptors: *Nebraska, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 159 streamflow gaging stations, 15 partial-record or miscellaneous streamflow stations, and 5 crest-stage, partial-record streamflow stations; stage and content records for 10 lakes and reservoirs; water-quality records for 43 streamflow stations, 16 ungaged streamsites, and 161 wells; and water-level records for 58 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (USGS) W90-05252

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1984.

Geological Survey, Boston, MA. Water Resources Div.
F. E. Blackey, J. E. Cotton, and K. W. Toppin.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-114476. Price codes: A07 in paper copy, A01 in microfiche. USGS Water-Data Report NH-VT-84-1 (WRD/HD-86/220), 1986. 133 p. Prepared in cooperation with the States of New Hampshire and Vermont and with other agencies.

Descriptors: *New Hampshire, *Vermont, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for New Hampshire and Vermont consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 71 gaging stations, stage records for 4 lakes, month-end contents for 24 lakes and reservoirs, water-quality data for 3 gaging stations, and water levels for 30 observation wells. Also included are data for 4 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. Locations of gaging stations, partial-record stations, and observation wells are shown on a map. A few pertinent stations (not included above) in bordering States and Province of Quebec are also included in this report. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Hampshire and Vermont. (USGS) W90-05253

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984, VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.

Geological Survey, Trenton, NJ. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and F. L. Schaefer.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-106101. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-84-1 (WRD/HD-85/234), 1985. 327 p. Prepared in cooperation with

the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *New Jersey, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of ground water. This volume of the report contains discharge records for 79 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 62 surface-water sites and 141 wells; and water levels for 54 observation wells. Also included are data for 41 crest-stage partial-record stations, 17 tidal crest-stage gages, and 39 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-05255) (USGS) W90-05254

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1984, VOLUME 2. DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.

Geological Survey, Trenton, NJ. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and F. L. Schaefer.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-102704. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-84-2 (WRD/HD-85/235), 1985. 184 p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *New Jersey, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of ground water. This volume of the report contains discharge records for 25 gaging stations; tide summaries for 3 stations; stage and contents for 16 lakes and reservoirs; water quality for 30 surface-water sites and 56 wells; and water levels for 27 observation wells. Also included are data for 27 crest-stage partial-record stations, 7 tidal crest-stage gages, and 18 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-05254) (USGS) W90-05255

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985, VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.

Geological Survey, West Trenton, NJ.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-227500/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-85-1 (WRD/HD-86/229), 1986. 319 p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *New Jersey, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of ground water. This volume of the report contains discharge records for 79 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 60 surface-water sites and 194 wells; and water levels for 36 observation wells. Also included are data for 44 crest-stage partial-record stations, 16 tidal crest-stage gages, and 42 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-05254 and W90-05257) (USGS) W90-05256

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1985, VOLUME 2. DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.

Geological Survey, West Trenton, NJ.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-116554. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-85-2 (WRD/HD-86/230), 1986. 191 p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *New Jersey, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of ground water. This volume of the report contains discharge records for 22 gaging stations; tide summaries for 3 stations; stage and contents for 18 lakes and reservoirs; water quality for 30 surface-water sites and 96 wells; and water levels for 23 observation wells. Also included are data for 28 crest-stage partial-record stations, 8 tidal crest-stage gages and 8 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-05254 and W90-05256) (USGS) W90-05257

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1984.

Geological Survey, Albuquerque, NM. Water Resources Div.
L. P. Denis, L. V. Beal, and H. R. Allen.
Available from the National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report NM-84-1 (WRD/HD-86/205), 1985. 485 p. Prepared in cooperation with the State of New Mexico and with other agencies.

Descriptors: *New Mexico, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments,

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Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 173 gaging stations; stage and contents for 25 lakes and reservoirs; water quality for 76 gaging stations and 196 wells; and 105 observation wells. Also included are 143 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (USGS) W90-05258

WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1985.

Geological Survey, Albuquerque, NM. Water Resources Div.
L. P. Denis, L. V. Beal, and H. R. Allen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-149977/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report NM-85-1 (WRD/HD-87/202), 1986. 482 p. Prepared in cooperation with the State of New Mexico and with other agencies.

Descriptors: *New Mexico, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 168 gaging stations; stage and contents for 25 lakes and reservoirs; water quality for 65 gaging stations and 179 wells; and water levels at 111 observation wells. Also included are 138 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection programs, and are published as miscellaneous measurements. Also, one seepage investigation is published this year. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (USGS) W90-05259

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1987. VOLUME 1. EASTERN OREGON.

Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, P. R. Boucher, R. L. Moffatt, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-155326/AS. Price codes: A10 in paper copy, A02 in microfiche. USGS Water-Data Report OR-87-1 (USGS/WRD/HD-90/234), 1989. 210p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Oregon, *Hydrologic data, *Surface water, *Water quality, *Gaging stations, *Data collections, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis.

Water Resources Data for the 1987 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 264 gaging stations; stage only records for 8 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 69 stations, and water

quality for 3 precipitation stations. Also included are 5 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-05261) (USGS) W90-05260

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1987. VOLUME 2. WESTERN OREGON.

Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, T. A. Herrett, R. L. Kraus, R. L. Moffatt, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-149709. Price codes: A18 in paper copy, A03 in microfiche. USGS Water-Data Report OR-87-2 (USGS/WRD/HD-90/235), 1989. 386p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Oregon, *Hydrologic data, *Surface water, *Water quality, *Gaging stations, *Data collections, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis.

Water Resources Data for the 1987 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 264 gaging stations; stage only records for 8 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 69 stations, and water quality for 3 precipitation stations. Also included are 5 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-05260) (USGS) W90-05261

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1987.

Geological Survey, Tacoma, WA. Water Resources Div.
E. H. McGavock, W. D. Wiggins, P. R. Boucher, R. L. Blaz, and L. L. Reed.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-150632. Price codes: A23 in paper copy, A03 in microfiche. USGS Water-Data Report WA-87-1 (USGS/WRD/HD-89/283), 1989. 509 p. Prepared in cooperation with the State of Washington and with other agencies.

Descriptors: *Washington, *Hydrologic data, *Surface water, *Water quality, Gaging stations, *Data collections, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis, Water level.

Water Resources Data for the 1987 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of wells. This report contains discharge records for 198 gaging stations; stage only records for 6 gaging stations; stage and (or) contents for 37 lakes and reservoirs; water quality for 34 stream-flow-gaging stations, 6 ungaged streamsites, and 130 National Water Quality Assessment Study streamsites; and water levels for 78 observation wells. Also included are data for 14 crest-stage partial-record stations and 138 partial-record or miscellaneous streamflow stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Washington. (USGS) W90-05262

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 2. LONG ISLAND.

Geological Survey, Albany, NY. Water Resources Div.
A. G. Spinello, J. H. Nakao, R. Busciolano, and R. B. Winowitch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-158809. Price codes: A11 in paper copy, A02 in microfiche. USGS Water-Data Report NY-88-2 (USGS/WRD/HD-89/276), 1989. 230p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Groundwater, *New York, *Hydrologic data, *Surface water, *Water quality, *Data collections, Gaging stations, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water level, Wells, Water temperature, Sampling sites, Water analysis.

Water Resources Data for the 1988 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 17 gaging stations; water quality at 16 gaging stations, and 169 wells; and water levels at 225 observation wells. Also included are data for 75 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data, together with the data in Volumes 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and other agencies in New York. (See also W90-05264) (USGS) W90-05263

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 3. WESTERN NEW YORK.

Geological Survey, Albany, NY. Water Resources Div.
J. B. Campbell, W. F. Coon, D. A. Sherwood, and D. D. Dellorf.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-156258. Price codes: A10 in paper copy, A02 in microfiche. USGS Water-Data Report NY-88-3 (USGS/WRD/HD-89/285), 1989. 198p. Prepared in cooperation with the State of New York and with other agencies.

Descriptors: *Groundwater, *New York, *Hydrologic data, *Surface water, *Water quality, *Data collections, *Groundwater, Gaging stations, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis, Water level, Wells.

Water Resources Data for the 1988 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 77 gaging stations; stage only at 19 gaging stations; stage and contents at 6 gaging stations; water quality at 4 gaging stations and 10 partial-record stations; and water levels at 21 observation wells. Also included are data for 47 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data together with data in Volumes 1 and 2 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See also W90-05263) (USGS) W90-05264

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1988. VOLUME 1, HAWAII.

Geological Survey, Honolulu, HI. Water Resources Div.

Field 7—RESOURCES DATA

Group 7C—Evaluation, Processing and Publication

R. H. Nakahara, J. J. S. Yee, I. Yamashiro, G. A. Tateishi, and J. A. Domingo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-157140/AS. Price codes: A13 in paper copy, A02 in microfiche. USGS Water-Data Report HI-88-1 (USGS/WRD/HD-90/236), 1989. 265p. Prepared in cooperation with the State of Hawaii and with other agencies.

Descriptors: *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, *Data collections, Gaging stations, Flow rates, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water Resources Data for the 1988 water year for Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, volume 1, contains discharge records for 82 gaging stations; water quality for 14 gaging stations, 54 partial-record flow stations, and 148 wells; and water levels for 37 observation wells. Also included are 107 crest-stage partial record stations, 25 miscellaneous partial-record sites, and 8 low-flow partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and other agencies in Hawaii. (USGS)
W90-05265

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1987.

Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Haut, D. M. Walters, T. E. Coffey, and D. K. White.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-159724. Price codes: A15 in paper copy, A02 in microfiche. USGS Water-Data Report OK-87-1 (USGS/WRD/HD-90/233), 1989. 324p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Oklahoma, *Hydrologic data, *Surface water, *Water quality, *Data collections, Gaging stations, Flow rates, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water analysis.

Water Resources Data for the 1987 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes or reservoirs. This report contains discharge records for 123 gaging stations; stage and contents for 30 lakes or reservoirs; water quality for 38 gaging stations and 3 lakes. Also included are 5 partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (USGS)
W90-05266

OPTIMIZATION OF VALUE OF CVP'S HYDROPOWER PRODUCTION.

Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 6B.
W90-05302

ECONOMIC RESERVOIR DESIGN AND STORAGE CONSERVATION BY REDUCED SEDIMENTATION.

Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2J.
W90-05304

MATHEMATICAL MODELLING OF WATER DISTRIBUTION NETWORKS UNDER STEADY-STATE CONDITIONS: RECENT DEVELOPMENTS AND FUTURE PROJECTS, (MODELISATION DES RESEAUX DE DISTRIBUTION D'EAU EN REGIME PERMANENT: EVOLUTIONS RECENTES ET PERSPECTIVES).

Societe Anonyme Francaise d'Etudes, de Gestion, et d'Enterprise, Nanterre (France).
For primary bibliographic entry see Field 5F.
W90-05317

ANALYSIS OF IMPROVED PARAMETER ESTIMATION IN LAKE MODELLING.

Politechnika Warszawska (Poland). Inst. of Environmental Engineering.
M. Loga.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie, Vol. 33, No. 1, p 201-212, November 1989. 5 fig, 1 tab, 7 ref.

Descriptors: *Limnology, *Model studies, *Lakes, *Mathematical models, Algorithms, Parameter estimation.

The possibility of improving commonly used methods of parameter estimation in ecological models was investigated. The method described is an attempt to establish a better convergence of the estimation algorithm when dealing with complicated ecological models. This method—Step By Step Merging Subsequent State Equations—allows: (1) decreasing the number of simultaneously estimated parameters by eliminating some of the state equations. Their solutions are substituted in the remaining equations by approximated values (e.g. Fourier series) obtained from the measurement data. (2) correcting the equations of the model, in the case when estimated parameters fail to match so-called 'reasonable values' (e.g. values reported in the literature). Isolating particular state equations allows the user to verify and eventually to correct its structure until approximately true parameter values are obtained. Applying well known sensitivity analysis allows better understanding of the model structure and thus enables further improvement of the estimation algorithm to be made. (Author's abstract)
W90-05471

INTEGRATION OF RIPARIAN DATA IN A GEOGRAPHIC INFORMATION SYSTEM.

Williamette National Forest, Eugene, OR.
M. A. Hemstrom.
IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 17-22. 6 fig, 8 ref.

Descriptors: *Geographic information systems, *Riparian vegetation, *Land management, *Water resources management, *Water law, *Geologic mapping, *Geohydrology, *Oregon, *Information systems, *Riparian land, *Riparian waters, Stream profiles, Forest watersheds, Computer models, Streams.

A geographic information system offers the opportunity to integrate stream resource information at the watershed scale. A case study using several information layers and their use in developing a stream enhancement project is presented. The geographic information system map and information bases for Cummins Creek, Oregon Coast Range, include geomorphic stream reaches, stand conditions, plant associations, large woody debris, woody debris, potential input of woody debris from riparian stands, and the location of areas most suitable for silvicultural treatment to increase the representation of decay-resistant large wood in riparian stands. Other kinds of analyses and models are possible using this information, including debris torrent potential, cumulative effects, and stream habitat evaluation and monitoring. (See also W90-05491) (Author's abstract)
W90-05495

EVALUATION OF THE U.S. FOREST SERVICE 'COWFISH' MODEL FOR ASSESSING LIVESTOCK IMPACTS ON FISHERIES IN THE BEAVERHEAD NATIONAL FOREST, MONTANA.

Montana Dept. of Fish, Wildlife and Parks, Helena.
For primary bibliographic entry see Field 4C.
W90-05496

SIMULATION MODEL FOR MANAGING FISHERIES IN RESERVOIRS ON THE RIO GRANDE OF NEW MEXICO.

New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
For primary bibliographic entry see Field 8I.
W90-05515

NULL HYPOTHESES, MODELS, AND STATISTICAL DESIGNS IN THE STUDY OF LARVAL TRANSPORT.

National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 2L.
W90-05545

STREAMFLOW AND WATER-QUALITY DATA FOR LITTLE CLEARFIELD CREEK BASIN, CLEARFIELD COUNTY, PENNSYLVANIA, DECEMBER 1987-NOVEMBER 1988.

Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05552

USE OF TEMPERATURE PROFILES BENEATH STREAMS TO DETERMINE RATES OF VERTICAL GROUND-WATER FLOW AND VERTICAL HYDRAULIC CONDUCTIVITY.

For primary bibliographic entry see Field 2A.
W90-05554

ESTIMATION OF RAINFALL FOR FLOOD FORECASTING USING RADAR AND RAIN GAGE DATA.

Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 7B.
W90-05589

1988 ANNUAL WATER QUALITY DATA REPORT FOR THE WASTE ISOLATION PILOT PLANT.

IT Corp., Carlsbad, NM.
For primary bibliographic entry see Field 5E.
W90-05598

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS 1984-87.

Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05600

LOW-FLOW PROFILES OF THE TALLAPOOSA RIVER AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05601

ESTIMATING FLOOD HYDROGRAPHS FOR ARKANSAS STREAMS.

Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05602

MEASUREMENT OF REAERATION COEFFICIENTS FOR SELECTED FLORIDA STREAMS.

Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05606

LOW-FLOW PROFILES OF THE TENNESSEE RIVER TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.

For primary bibliographic entry see Field 2E.
W90-05612

LOW-FLOW PROFILES OF THE UPPER SAVANNAH AND OGECHEE RIVERS AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05613

LOW-FLOW PROFILES IN THE UPPER OCONEE RIVER AND TRIBUTARIES IN GEORGIA.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05614

GENERAL METHOD FOR GENERATING BATHYMETRIC DATA FOR HYDRODYNAMIC COMPUTER MODELS.

Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Burau, and R. T. Cheng.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-28, 1989. 45p, 12 fig, 6 ref, 2 append.

Descriptors: *Data interpretation, *Model studies, *Bathymetry, *Information retrieval, Water depth, Hydrodynamics, Computer models, Mathematical analysis.

To generate water depth data from randomly distributed bathymetric data for numerical hydrodynamic models, raw input data from field surveys, water depth data digitized from nautical charts, or a combination of the two are sorted to give an ordered data set on which a search algorithm is used to isolate data for interpolation. Water depths at locations required by hydrodynamic models are interpolated from the bathymetric data base using linear or cubic shape functions used in the finite-element method. The bathymetric database organization and preprocessing, the search algorithm used in finding the bounding points for interpolation, the mathematics of the interpolation formulae, and the features of the automatic generation of water depths at hydrodynamic model grid points are included in the analysis. This report includes documentation of two computer programs which are used to: (1) organize the input bathymetric data; and (2) to interpolate depths for hydrodynamic models. An example of computer program operation is drawn from a realistic application to the San Francisco Bay estuarine system. (Author's abstract)
W90-05620

8. ENGINEERING WORKS

8A. Structures

FOAM RUBBER MODELING OF TOPOGRAPHIC AND DAM INTERACTION EFFECTS AT PACOIMA DAM.

Nevada Univ., Reno. Seismological Lab.
For primary bibliographic entry see Field 7C.
W90-04583

REVIEW ON THE DESIGN AND CONSTRUCTION OF A LARGE WASTEWATER TREATMENT PLANT.

Delfland Water Authority, Delft (Netherlands).
For primary bibliographic entry see Field 5D.
W90-04775

FINITE ELEMENT ANALYSIS OF EFFECT OF PIPE COOLING IN CONCRETE DAMS.

Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
Z. Bofang, and C. Jianbo.
Journal of Construction Engineering and Management (ASCE) JCEMD4, Vol. 115, No. 4, p 487.

498, December 1989. 12 fig, 5 ref.

Descriptors: *Dam construction, *Concrete dams, *Temperature control, *Water cooling, *Finite element method, Dam design, Pipe cooling, Cooling water, Computer programs, Statistical analysis.

Pipe cooling is widely adopted to control the temperature of concrete dams. There is no suitable method to compute the effect of simultaneous cooling of the embedded pipe and the lift surface of concrete. In this paper the finite element method is used for calculation of this complicated three-dimensional problem. The key is determining the temperature of the cooling water. Three methods ('simple', 'iteration', and 'prediction') are given for analyzing the interaction between the cooling water and the concrete, and the formulas required in computation are derived. A computer program for general use was developed. The effects of pipe cooling on the temperature field of mass concrete, of change of flow direction of the cooling water on the temperature field and of 'straightening the pipe coils' (to simplify calculation) are shown. A practical computing method and relevant charts are presented for the convenience of engineers. (Sand-PTT)
W90-04814

TATSUMI CANAL OF 1632, JAPAN.

Kanazawa Inst. of Tech. (Japan).
T. Nakagawa, and S. Miyae.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 87, No. part 2, p 1143-1165, December 1989. 26 fig, 2 tab, 12 ref, 2 append.

Descriptors: *Japan, *Canal design, *Canal construction, *Water conveyance, *Water distribution, Tatsumi Canal, History, Excavation, Hydraulics, Pipes.

The Tatsumi Canal, constructed in 1632, is a monumental work remarkable in the history of Japanese water supply canals. The technologies used in the hydraulics, channel excavation, the water conveyance pipe system and pipe manufacture are reviewed. The water head loss was minimized by widening at bends, by cutting a curved groove along the channel bed near the inner rounded corner of the bend, and by minimizing the surface roughness of the channel. The bed slope was determined with a simple instrument to find the horizontal level, and a modern arch-like structure was used to prevent cave-in of the closed channel. In the water conveyance pipe system, which ranged over 640 m and 11.4 m in horizontal and vertical distances, respectively, the inverted-siphon principle was applied to transport the water with the hydraulic head loss within 3.4 m. In pipe manufacture, claw coupling was adopted for rock pipes and joint rocks were used to change the direction of pipe conduit. The Tatsumi Canal is well preserved and is still operational in the original manner. The general level of technologies in aqueduct construction in the early 17th century Japan can therefore be appreciated. The canal has features of great cultural importance which must be preserved, because other canals constructed in the same period have been greatly modified or completely destroyed. (Author's abstract)
W90-04991

EUR WATER STATION OF THE ACEA (MUNICIPAL ELECTRICITY AND ENVIRONMENT BOARD), ROME.

Rome Univ. (Italy).
P. Martini, and F. Ciacchella.
Aqua AQUAAA, Vol. 30, No. 6, p 358-368, December 1989. 8 fig, 2 tab.

Descriptors: *Rome, *Water tanks, *Hydraulic design, *Municipal water, Water storage, Model testing, Construction materials, Design criteria, Aqueducts, Italy.

The EUR water station constitutes another stage in the great 'General Plan for the Collection and Distribution of Water in Rome' prepared by ACEA in 1963 and approved in 1965 by an interdepartmental order. The EUR station represents the most important outcome led by the Electricity

and Environmental Municipal Board of Rome (ACEA) by making an industrial structure a decorative city element. The architectural part of the design was carried out by Professor Palpacelli (Architect) with the joint effort of some ACEA departments. This article describes the architecture of the EUR water station and the functions of the different elements. All of the standards adopted for the design of the static structures and the waterworks of the station are detailed. The EUR water station has been under construction since May 1986 and will be completed in the spring of 1990. The station rises to 88 m above ground level with an architectural solution that points out the structural elements and gives an aesthetic result. The construction is entirely metal; passivated-treated steel is used, together with nickel-chrome stainless steel for the outer layer—a total of over 1600 tons of weight. Once completed, the maximum flow-rate distributed by the station will be 3600 L/sec. The design (including schematics diagrams), construction materials, and model testing are detailed. The EUR station in operation, fed by the Pesciera-Capora aqueduct system, will supply water to the city districts of EUR, Laurentino, Ostiense and a part of Ardeatino and the wards of Tessorio, Ripa and S. Saba, along with water stations in Cecchignola and Ostia Lido. With completion of the EUR water station, whose total cost will amount to over 21 billion lire, ACEA will offer to Roman and foreign citizens an interesting new waterworks to visit. (Author's abstract)
W90-05318

CHANNEL TUNNEL, TEXAS STYLE.

Brown and Root Development, Inc., Houston, TX.
For primary bibliographic entry see Field 8H.
W90-05349

TRANSPORT MODEL FOR WATER EXCHANGE BETWEEN COASTAL INLET AND THE OPEN OCEAN.

State Univ. of New York at Stony Brook. Marine Sciences Research Center.
For primary bibliographic entry see Field 2L.
W90-05534

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.

Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 5G.
W90-05618

8B. Hydraulics

APPLICABILITY OF THE SECOND-ORDER DISPERSION MODEL.

Technische Univ., Karl-Marx-Stadt (German D.R.). Dept. of Numerical Methods and Computer Technology.
K. Klotz.
Water Resources Research WREARQ, Vol. 25, No. 12, p 2497-2500, December 1989. 2 fig, 14 ref, append.

Descriptors: *Dispersion, *Pipe flow, *Mixing, *Solute transport, *Dispersion, *Model studies, Mathematical models, Convection, Injection, Pulse.

The convective transport of a dissolved chemical species in a pipe is studied both for an injection and pulse problem. The entire solutions of the equations of the second-order dispersion model for the averaged mass fraction of the solute are derived in the case of no molecular diffusion. Although the exact representation of $v'v'w'$, sub x and $v'w'$, sub ii (where v' is the deviation value of the microscopic fluid velocity and w' is the averaged mass fraction of dissolved chemical species) deviate from corresponding constitutive equations proposed by Tompon and Gray, they do not reflect the influence of diffusion in the overall dispersion processes considered in Tompon and Gray's validation exercises. The dispersion coefficient of the injection

Field 8—ENGINEERING WORKS

Group 8B—Hydraulics

problem considered clearly exhibits a scale effect.
(Author's abstract)
W90-04666

SEVERAL SOURCES OF NONUNIFORMITY IN IRRIGATION DELIVERY FLOWS.
Agricultural Research Service, Phoenix, AZ.
Water Conservation Lab.
For primary bibliographic entry see Field 3F.
W90-04815

EFFECT OF REACTOR HYDRAULICS ON THE PERFORMANCE OF ACTIVATED SLUDGE SYSTEMS: I. THE TRADITIONAL MODELLING APPROACH.
Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-04839

FINITE ANALYTIC SOLUTION OF FLOW OVER SPILLWAYS.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China).
W. Li, Z. Xie, and C. J. Chen.
Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 115, No. 12, p. 2635-2648, December 1989. 5 fig, 1 tab, 12 ref, append.

Descriptors: *Spillways, *Mathematical studies, *Finite difference methods, *Gravity flow, *Hydrodynamics, *Hydraulics, *Model studies, Finite analytic method, Dams, Discharge coefficient.

Two-dimensional irrotational gravity flows over a spillway with a free surface are investigated numerically and compared to available experimental measurements. The difficulty of the present problems lies in that both the free surface elevation and flow rate are unknowns, even when the reservoir and spillway crest heights are given. In order to solve the problem, the boundary-fitted coordinate system is adapted to map the complex domain into a rectangular domain with uniform meshes. The finite analytic method is used to obtain the numerical solution. In the finite analytic method, the local analytic solution of the governing equation in an element is obtained and used to formulate the algebraic representation of the governing equation. The discharge coefficient is deduced by a scan method according to the variational principle for variable domains. The prediction is made for the Waterways Experimental Station spillway, where extensive data are available for comparison. The numerical results agree well with experimental data on discharge coefficients and free surface elevation. (Author's abstract)
W90-04962

BACKWATER LENGTHS IN RIVERS.
Hydraulics Research Ltd., Wallingford (England). P. G. Samuels.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 87, No. part 2, p. 571-582, December 1989. 1 fig, 3 tab, 14 ref, append.

Descriptors: *River flow, *Backwater, *Flow profiles, *Backwater curve, *Hydrodynamics, *Hydraulic engineering, Canals, Drainage pumps, Gaging stations, Discharge routing.

River engineers need to have simple estimators which are helpful in quantifying the probable size of some parameter or process. A characteristic length scale for a river at a particular location based on an approximate solution to the full flow equations is introduced. This parameter, the backwater length, L_b , is equal to $0.7 D/s\text{-sub-o}$, where D is the bankfull depth of the channel and $s\text{-sub-o}$ is the mean slope. Several practical examples where this estimate has been used are: (1) upstream influence of works in a river channel; (2) location of hydraulic model boundary; (3) tailgate control on a physical model; (4) location of control structures on a canal; (5) operation of automatic land drainage pumps; (6) spacing of cross-sections in a computational model; (7) analysis of gaging station records; and (8) validity of discharge routing. (Sand-PTT)

W90-04990

FURTHER RESEARCH ON APPLICATION OF PROBABILITY WEIGHTED MOMENTS IN ESTIMATING PARAMETERS OF THE PEARSON TYPE THREE DISTRIBUTION.
Chengdu Univ. of Science and Technology (China).
For primary bibliographic entry see Field 7C.
W90-05000

OPTIMUM DESIGN OF LARGE SEWER NETWORKS.
Kuwait Inst. for Scientific Research, Safat. Techno-Economics Div.
For primary bibliographic entry see Field 5D.
W90-05025

MICROCOMPUTER MODEL FOR SIMULATING PRESSURIZED FLOW IN A STORM SEWER SYSTEM.
Virginia Transportation Research Council, Charlottesville.
S. L. Yu, and Y. Wu.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-127906. Price codes: A03 in paper copy, A01 in microfiche. Report No. FHWA/VA-89-R5, August 1988. Interim Report. 13p, 8 fig, 1 tab, 8 ref.

Descriptors: *Computer programs, *Pipe flow, *Hydraulics, *Computer models, *Model studies, *Simulation analysis, *Storm sewers, Flow profiles, Hydrodynamics, Storm Water Management Model, Pressure conduits, Sewer hydraulics, Illinois Urban Drainage Simulation, Surface water, Mathematical studies.

A study is being conducted on the development of a microcomputer model for simulating storm sewer flow under surcharged or pressurized conditions. Several existing models, including the EPA Storm Water Management Model (SWMM) and the Illinois Urban Drainage Simulation (ILLUDAS), have been reviewed. It was concluded that the SWMM program's EXTRAN subroutine would be suitable for this purpose. Certain modifications of EXTRAN will be necessary, and the modified subroutine will be incorporated into the Federal Highway Administration's Pooled Fund Storm Sewer Program PFP-HYDRA. EXTRAN uses a full dynamic wave approach that can better simulate unsteady flow characteristics in a sewer system. In addition it has the capability to handle both free-surface flow and pressurized flow. EXTRAN can be modified in several ways: (1) excess surface water could be stored in a detention area connected to the manhole and treated as if it will return to the sewer system at a later time; (2) the numerical scheme could be modified by increasing the accuracy of the solution of the differential equations; (3) some less important hydraulic structures and pipe shapes and plot subroutines, could be dropped from EXTRAN in order to reduce the running time; and/or (4) a modified EXTRAN could aid PFP-HYDRA in its analysis model to give the user options to route free surface flow or open-channel and surcharge flows. It would predict the location of the surcharge pipe, the duration of the surcharge, and the flow and hydraulic gradeline at selected locations in the system. (Lantz-PTT)
W90-05136

NEW REVETMENT DESIGN CONTROLS STREAMBANK EROSION.
Forest Service, Albuquerque, NM. Southwestern Region.
For primary bibliographic entry see Field 4D.
W90-05331

NEW METHOD OF STREAM BANK PROTECTION.
Saint Charles City Engineer's Office, MO.
For primary bibliographic entry see Field 4D.
W90-05332

EMERGENCY WATERSHED PROTECTION USING STRAW BALES.
Miles (Thomas R.), Portland, OR.
For primary bibliographic entry see Field 4D.
W90-05334

INDUCED SURFACE FLOW IN A MODEL RESERVOIR.
Calgary Univ. (Alberta). Dept. of Chemical and Petroleum Engineering.
For primary bibliographic entry see Field 2H.
W90-05463

OBSERVATIONS ON INLET FLOW PATTERNS DERIVED FROM NUMERICAL AND PHYSICAL MODELING STUDIES.
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 2L.
W90-05535

NAVIGATION CONDITIONS AT OLIVER LOCK AND DAM BLACK WARRIOR RIVER PROJECT: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. T. Wooley.

Available from the National Technical Information Service, Springfield, VA 22161, as AD-A216924. Price codes: A06 in paper copy, A01 in microfiche. Technical Report HL-89-27, September 1989. Final Report. 117p, 14 fig, 9 tab, 40 photos, 44 plates.

Descriptors: *Alabama, *Hydraulic models, *Navigation, Oliver Lock and Dam, Black Warrior River, Hydraulic structures, River flow, Dams, Locks.

William Bacon Oliver Lock and Dam is located on the left descending bank of the Black Warrior River about 346.3 river miles above Mobile, AL, in the corporate limits of Tuscaloosa, AL. The principal existing structures are a 700-ft-long fixed-crest spillway and a 95-ft by 460-ft lock. The dam forms a run of the river pool that extends 8.8 miles upstream to Holt Lock and Dam. During high pool elevation and river discharges, flows bypass the lock and navigate over the fixed-crest weir. Oliver Lock has the smallest chamber (95 by 460 ft) on the Black Warrior-Tombigbee Waterway, and the present plan of development is to replace the existing lock and dam with a new structure located about 2,300 ft downstream. The replacement structure will provide a 110-ft by 600-ft lock chamber and an 815-ft-long fixed-crest spillway. A fixed-bed model reproduced about 2.8 miles of the Black Warrior River channel and adjacent overbank area to an undistorted scale of 1:100. Results of the investigation indicated that satisfactory navigation conditions can be established through the reach with all flows tested; however, with higher riverflows and current velocities, certain maneuvers may be required for downbound tows to approach the lock. With the higher riverflows, the alignment of the currents was satisfactory for upbound and downbound tows to approach the fixed-crest dam; however, the drop across the dam could create some difficulties and require considerable power for tows to navigate over the dam. With the first-stage cofferdam in place for construction of the replacement lock, considerable power and maneuvering could be required for upbound tows to move past the cofferdam with riverflows of 30,000 cu ft/sec and above. With the second-stage cofferdam in place, a training structure placed in the vicinity of the lower lock approach of the replacement lock will provide satisfactory conditions for tows entering and leaving the lower lock canal with riverflows through 100,000 cu ft/sec. (Lantz-PTT)
W90-05587

8C. Hydraulic Machinery

MULTICRITERION ANALYSIS OF HYDRO-POWER OPERATION.

Materials—Group 8G

Case Western Reserve Univ., Cleveland, OH.
Dept. of Systems Engineering.
For primary bibliographic entry see Field 6B.
W90-04975

LOW-HEAD HYDRO: AN EXAMINATION OF AN ALTERNATIVE ENERGY SOURCE.
Idaho Water Resources Research Inst., Moscow.
For primary bibliographic entry see Field 6A.
W90-05137

EUR WATER STATION OF THE ACEA (MUNICIPAL ELECTRICITY AND ENVIRONMENT BOARD), ROME.
Rome Univ. (Italy).
For primary bibliographic entry see Field 8A.
W90-05318

ENERGY FROM THE AMAZON.
J. D. Cadman.
Civil Engineering (ASCE) CEWRA9, Vol. 59, No. 12, p 54-57, December 1989. 1 fig.

Descriptors: *Dams, *Hydroelectric plants, *Amazon River, *River basin development, Water resources development, Water quality, Brazil, Deforestation, Dam effects.

Brazil's need for electrical energy has made the development of hydroelectric power in the Amazon River basin a primary focus. Eleven hydroelectric projects have entered the planning stages, are presently under construction or are now in operation. The location, construction specifications and power capacity of these projects are briefly summarized. Concerns related to the hydroelectric development of the Amazon basin include: deforestation due to flooding and human migration into areas utilized by the power plants; muddying and mercury contamination of waters downstream from mining operations; and reduction of Indian reservation lands. It is suggested that the removal of valuable timber from flood land, once the reservoir is filled, may provide a cost-efficient way to minimize deforestation. Problems stemming from mining practices call for greater government control, such an effort, however, may require funding that is beyond the Brazilian government's present capabilities. Water quality is affected by the depletion of oxygen and the production of methane and hydrogen gases in the lower portion of the reservoir. To prevent water quality problems for populations downstream from the Tucuruí Dam, the practice of allowing oxygen-rich spillway water to mix with oxygen-deficient water from the power house is carried out during the dry season. The reduction of Indian reservation land has resulted in conflict between tribes and settlers. However, the resettlement of communities affected by the Tucuruí reservoir shows that resettlement can be accomplished without serious problems, if well-planned and carried out. (Male-PTT)
W90-05350

HYDRAULIC TURBOCHARGER(TM): A NEW TYPE OF DEVICE FOR THE REDUCTION OF FEED PUMP ENERGY CONSUMPTION IN REVERSE OSMOSIS SYSTEMS.
Naval Civil Engineering Lab., Port Hueneme, CA.
For primary bibliographic entry see Field 3A.
W90-05430

HEAT BUDGET OF A HIGH MOUNTAIN RESERVOIR IN THE CENTRAL PYRENEES.
Barcelona Univ. (Spain).
For primary bibliographic entry see Field 2H.
W90-05459

8D. Soil Mechanics

FILL SLOPE REPAIR USING SOIL BIOENGINEERING SYSTEMS.
Sotir (Robbin B.) and Associates, Marietta, GA.
R. B. Sotir, and D. H. Gray.
Public Works PUWOAH, Vol. 120, No. 13, p 37-40, 77, December 1989. 3 fig, 1 tab.

Descriptors: *Slope stabilization, *Erosion control, *Soil engineering, *Soil erosion, Slope protection, Slope degradation, Sediment control, Planting management, Stability analysis, North Carolina, Construction materials.

Soil bioengineering is an applied science, combining mechanical, biological, and ecological concepts to construct living structures for erosion, sediment, and flood control. Plant parts are used as the major structural components to reinforce the soil mantle. Soil bioengineering systems function immediately as soil reinforcing units and as barriers to surface erosion. In time, roots and shoots develop to further enhance stability. The North Carolina Dept. of Transportation chose a failing slope site about sixty miles east of Asheville as the test for soil bioengineering systems. The demonstration site was an 870 ft long fill slope having a southern exposure, and a maximum height of 60 ft, with the slope varying from 1.5:1 to 2:1. Robbin B. Sotir & Associates was contracted to develop preliminary construction plans, procedures and specifications for the project in 1986. Stability analyses were made, including determining the factor of safety, the effect of plant roots on the soil, and infinite slope analysis. The site was divided into three major areas with different systems to be installed in each area: live staking, live cribwall, cut brushlayers, and live fascines for fairly stable Area 1 (2:1 slope); fill brushlayers, reinforced brushlayers, live staking, and rooted plants for heavily eroded Area 2 (1.5:1 slope); and cut brushlayers, live fascines, and live staking for Area 3 (1.5:1 to 2:1 slope). Live material requirements, construction techniques, and spacing and width requirements from brushlayers were planned for each area. Installation of each of the bioengineering systems used are discussed, including live staking, brushlayering, live fascine, and live cribwall installation. Soil bioengineering is an excellent way to repair many shallow mass wasting and slope erosion problems. Systems installed on this demonstration project permanently stabilized the fill slope providing soil reinforcement from plant stems, induration and reinforcement from adventitious roots, and favorable modifications of the soil moisture regime near the face of the slope. (VerNooy-PTT)
W90-05333

8E. Rock Mechanics and Geology

GEOCHEMISTRY AND ISOTOPE HYDROGEOLOGY OF THE MOUNT EDZIZA-MESS CREEK GEOTHERMAL AREA.
Piteau (D.R.) and Associates Ltd., Vancouver (British Columbia).
I. D. Clark, P. Fritz, and J. G. Souther.
Canadian Journal of Earth Sciences CJESAP, Vol. 26, No. 6, p 1160-1171, 1989. 7 fig, 4 tab, 39 ref.

Descriptors: *Geohydrology, *Geochemistry, *Geothermal studies, *Volcanoes, *Thermal water, *Isotope studies, Paleohydrology, Geologic history, Thermal groundwater, Mount Edziza, Canada, Groundwater movement.

The Mount Edziza volcanic complex, a recent volcano within British Columbia's northern Intermontane Belt, and the adjacent Mess Creek valley, were investigated to evaluate the origin, geothermal history, and age of associated thermal waters. Samples of thermal and cold groundwaters, runoff, and glacier ice were collected for chemical and environmental isotope analysis. Mount Edziza thermal waters, discharging at 36 and 46 C from extensive travertine formations at the base of the volcanic pile, originate as glacier meltwater on the summit of the complex. Their Na(Ca,Mg)-HCO₃ chemistry is a product of alteration reactions with alkali basalts under a high CO₂ partial pressure. Chemical and isotope geothermometers suggest that subsurface temperatures are less than about 100 C. Carbon-13 data show that the high carbon dioxide contents (close to 1 bar (100 kPa) pressure) likely originate through high-temperature decarbonation of marine carbonates at depth, and manifest a deep geothermal component in an essentially high-level geothermal flow system. Mess Creek thermal waters discharge at 43 C from a fault-

controlled flow system unrelated to the Mount Edziza complex, showing evidence of equilibrium with local basement rocks at temperatures less than about 100 C. Deep circulation within a region of slightly higher than normal geothermal gradients is given as the mechanism for heating. The low H₃ contents suggest that the thermal waters are tritium free (> 30 yrs old) and are mixing with between 10 and 40% nonthermal groundwater in the discharge areas. (Author's abstract)
W90-04585

8G. Materials

PLASTIC PIPE: A CHANCE FOR REVIVAL.
Simpson Gumpertz & Heger, Inc., Arlington, MA.
R. E. Chambers.
Water Engineering and Management WENMD2, Vol. 136, No. 6, p 27-31, June 1989.

Descriptors: *Pipes, *Water conveyance, *Conveyance structures, *Plastic pipes, Design standards, Design criteria, Stress, Tensile stress, Performance evaluation, Hydraulic structures, Plumbing.

The new and revised American Water Works Association (AWWA) standards for plastic waterworks pipe are reviewed. These revisions include dramatic size increases and significant new provisions on materials, design and installation. The new requirements should ultimately result in improved reliability. Environmental stress crack resistance is a key index of long-term performance capabilities of polyethylene pipe materials. The new standards of polyethylene pipe introduced the newer state-of-the-art materials, namely PE 2406 and PE 3408, while retaining the older compounds with environmental stress crack resistance ratings. A new and more stringent elevated-temperature sustained-pressure test, performed at 80 C under constant water pressure, replaces the original sustained-pressure test that was performed at room temperature. For the first time, a simple 'bent-strip' test can be used to check pipe quality before installing it underground. Also, the new standard for fiberglass pipe now includes a range of stiffness classes, ranging from 9 to 72 psi, rather than a single minimum stiffness of 10 psi. Finally, a new calculation, derived from pipe-soil interaction tests, has been included in the fiberglass standard for combined loading stress (strain) due to the effects of internal pressure and external earth load. This accounts for the lower bending stresses that develop as flexible pipe, naturally ovoided underground, becomes more circular as the pipe is pressurized in service. (Friedmann-PTT)
W90-04575

DEVELOPMENT OF THE PIPE LOOP SYSTEM FOR DETERMINING EFFECTIVENESS OF CORROSION CONTROL CHEMICALS IN POTABLE WATER SYSTEMS.
Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 5F.
W90-05148

ACCURACY OF ACOUSTIC VELOCITY MEASURING SYSTEMS FOR MEASUREMENT OF LOW VELOCITY IN OPEN CHANNELS.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-05190

PROTECTIVE COATINGS AT A WASTEWATER TREATMENT PLANT.
Willow Lake Wastewater Treatment Plant, Salem, OR.
For primary bibliographic entry see Field 5D.
W90-05328

ALBUQUERQUE'S SEWER REHABILITATION PROGRAM.
Albuquerque's Wastewater Line Maintenance,

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NM.

For primary bibliographic entry see Field 5D.
W90-05329

ELECTROCHEMICAL MONITORING OF THE PROCESS OF BOILER CLEANING.

Water and Electricity Dept., Abu Dhabi (United Arab Emirates). Material Testing Lab.

For primary bibliographic entry see Field 3A.
W90-05436

MEASUREMENT OF LOCALIZED METAL REMOVAL IN PIPES BY GAMMA-RAY BACK-SCATTERING METHOD.

King Abdulaziz Univ., Jeddah (Saudi Arabia). Coll. of Engineering.

For primary bibliographic entry see Field 3A.
W90-05437

NEUTRON-CAPTURE GAMMA-RAY TECHNIQUE FOR SCALE IDENTIFICATION INSIDE PIPES.

King Abdulaziz Univ., Jeddah (Saudi Arabia). Coll. of Engineering.

For primary bibliographic entry see Field 3A.
W90-05438

8H. Rapid Excavation

CHANNEL TUNNEL, TEXAS STYLE.

Brown and Root Development, Inc., Houston, TX. D. Ivor-Smith, and S. Nandagiri. Civil Engineering (ASCE) CEWR9A, Vol. 59, No. 12, p 40-43, December 1989. 4 fig.

Descriptors: *Tunnel construction, *Water delivery, Cost analysis, Water transport, Pipes, Excavation, Sediments, Houston Ship Channel Tunnel, Greens Bayou, Design criteria.

Two tunnels are being constructed in soft ground beneath the Houston Ship Channel and Greens Bayou as part of the Houston area's water delivery system. When completed the tunnels will convey 320 million gal/day of raw water to one of Houston's water purification plants. The initial tunnel specifications emphasized the minimization of risks to lower costs either through the initial bid or as a result of claim mitigation. Seismic investigations helped delineate clay zones and showed the need to place the tunnels deeper. Pipeline depth and cost considerations dictated a primary lining of bolted steel segments with a 10 ft, 2 inch diameter to provide the necessary clearance for the 108 inch steel carrier pipe. Deflection studies of linear deformation caused by ground stress showed that overstress was not occurring and the values obtained came in close agreement with the 0.5 inch design criteria. Shafts were constructed using circular concrete caissons sunk from sheetpile and ring wale starter pits. The measured heave resulting from deep excavations ranged between 1.7 inches and 2.2 inches, indicating that the ground and tunnels were behaving as expected. A 133 inch diameter Lovat TBM, which features the ability to convert to an earth pressure balance shield when necessary, was used for the deep tunnel drives. Since the TBM was designed with a stroke allowing simultaneous erection of two 2 ft. wide rings, it was possible to reduce ring erection time considerably by prebolting adjacent segments of two rings at the fabricator shop. Advance rates averaged 30 ft per 12 hour shift, with a maximum of 64 ft in a single shift. Tunneling is expected to continue into 1990, with the deep Greens Bayou tunnel being the last drive to be completed. (Male-PTT)
W90-05349

8I. Fisheries Engineering

DEVELOPMENT OF WATER RELEASE PLANS FOR MINIMIZING FISH KILLS BELOW TULSA DISTRICT, CORPS OF ENGINEERS IMPOUNDMENTS.

Corps of Engineers, Tulsa, OK. Tulsa District. S. L. Nolen, J. H. Carroll, and J. N. Veenstra. Journal of Environmental Systems JEVSBH, Vol.

18, No. 4, p 353-366, 1988/89. 3 fig, 2 tab, 9 ref.

Descriptors: *Dam effects, *Thermal pollution, *Water pollution effects, *Anoxic conditions, *Fish management, *Temperature effects, *Fish-kill, Mortality, Water temperature, Fish populations, Reservoirs, Reservoir releases, Dissolved oxygen, Eufaula Lake, Tailwater.

Late summer fish kills comprised primarily of striped bass (*Morone saxatilis*) and associated with high water temperatures, low levels of dissolved oxygen (DO) and fish entrapment occasionally occur in the tailwaters of Tulsa District, Corps of Engineers impoundments. In response to these kills, studies were initiated to develop means of using minimal water releases to consistently maintain adequate temperature and dissolved oxygen conditions for fish survival below these projects. Activities included the use of the computer model, SELECT, for the prediction of minimum required releases, followed by field verification of predicted release characteristics. At Eufaula Lake, Oklahoma, release plans were developed for preventing tailwaters anoxia resulting from leakage of low DO waters through power penstocks. At Ft. Gibson Lake, Oklahoma, releases were used to prevent fish mortality caused by elevated water temperatures. In both instances, the SELECT model adequately predicted release characteristics and low level (approximately 0.7 cu m/sec), continuous sluice releases were successfully used to prevent fish kills. (Author's abstract)
W90-04607

GROWTH POTENTIALITIES OF THE GIANT TROPICAL PRAWN, MACROBRACHIUM ROSENBERGII (DE MAN), IN WASTE-HEAT DISCHARGE WATERS OF A THERMOELECTRIC POWER STATION.

Akademiya Navuk BSSR, Minsk. Inst. of Zoology. N. N. Khmeleva, V. F. Kulesh, and Y. G. Guiguiniak.

Aquaculture AQCLAL, Vol. 81, No. 2, p 111-117, October 1989. 2 fig, 1 tab, 20 ref.

Descriptors: *Crustaceans, *River shrimp, *Aquaculture, *Powerplants, *Waste heat, *Thermal water, *Cooling ponds, Growth rates, USSR, Thermal powerplants.

Giant tropical prawns, *Macrobrachium rosenbergii*, of up to 60 g live weight have been grown in waste-heat discharge waters of an electricity generating station in the USSR. The giant prawns were raised in mesh bags placed in a running water pond which received water from a heat discharge canal of the powerplant. The type of growth of the prawns changes during ontogeny in accordance with an S-shaped curve. Daily average growth rates are defined for various feed and rearing conditions. Cooling reservoirs of power-generating plants can be used for rearing prawns both on an artificial diet and with natural feed. Nearly 80% of the prawns attain a marketable mass of 20-35 g within 160-180 days in warm waste waters. Annual yields amount to 3,000-3,500 kg/ha. (Sand-PTT)
W90-04637

ECONOMIC TARGETING OF NONPOINT POLLUTION ABATEMENT FOR FISH HABITAT PROTECTION.

Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.

For primary bibliographic entry see Field 5G.
W90-04657

FACTORS INFLUENCING SALMONID POPULATIONS IN SIX HEADWATERS STREAMS, CENTRAL ARIZONA, USA.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.

For primary bibliographic entry see Field 2H.
W90-04729

SIGNIFICANCE OF TEMPERATURE AND FOOD AS FACTORS AFFECTING THE GROWTH OF BROWN TROUT, *Salmo trutta* L., IN FOUR DANISH STREAMS.

Miljøstyrelsen, Silkeborg (Denmark). Freshwater Lab.

For primary bibliographic entry see Field 2H.
W90-04730

FISH PRODUCTION-BENTHOS PRODUCTION RELATIONSHIPS IN TROUT STREAMS.

Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.

For primary bibliographic entry see Field 2H.
W90-04731

SOME PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON (*Salmo salar*) EXPOSED TO SOFT, ACIDIC WATER DURING SMOLTING.

Department of Fisheries and Oceans, Halifax (Nova Scotia). Biological Sciences Branch.

For primary bibliographic entry see Field 5C.
W90-04858

EVIDENCE FOR FLUORIDE EFFECTS ON SALMON PASSAGE AT JOHN DAY DAM, COLUMBIA RIVER, 1982-1986.

National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center.

For primary bibliographic entry see Field 5C.
W90-04915

YOUNG FISH DISTRIBUTION IN BACKWATERS AND MAIN-CHANNEL BORDERS OF THE KANAWHA RIVER, WEST VIRGINIA.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.

For primary bibliographic entry see Field 2H.
W90-05296

STRANDING OF FISHES BELOW MCALPINE DAM ON THE OHIO RIVER.

Louisville Univ., KY. Water Resources Lab. W. D. Pearson, and M. A. Froedge.

Transactions of the Kentucky Academy of Science TKASAT, Vol. 50, No. 3/4, p 183-210, Sep 1989. 1 fig, 4 tab, 46 ref.

Descriptors: *Ohio River, *Stream fisheries, *Dam effects, Fish stranding, Seasonal variation, Locks, Fish populations.

Many fishes are stranded on dewatered substrates below McAlpine Locks and Dam on the Ohio River at Louisville, Kentucky, when the upper gates of the dam are closed during periods of low flow, usually June to October. Between 11 June 1984 and 21 April 1985 there were 15 monitored stranding events and 166,437 stranded fishes of 54 species were counted. The 10 fishes stranded in greatest numbers were: emerald shiner, freshwater drum, gizzard shad, mooneye, smallmouth buffalo, goldeye, sauger, skipjack herring, channel catfish, and blue sucker. Numbers of fish stranded were correlated with time of final closure, season, temperature, turbidity, discharge and lower pool elevation. Mitigation techniques recommended include altering times, rate and sequence of gate closures and manipulation of lower pool elevations. (Author's abstract)
W90-05309

HEAT DEATH OF FISH IN SHRINKING STREAM POOLS.

Miami Univ. Middletown, OH. Dept. of Zoology. N. D. Mundahl.

American Midland Naturalist AMNAF, Vol. 123, No. 1, p 40-46, January 1990. 3 tab, 23 ref.

Descriptors: *Intermittent streams, *Fish populations, *Thermal stress, *Temperature effects, Water temperature, Ponds, Fish, Ohio, Mortality, Shiner, Minnow, Darters, Streams, Environmental effects.

During early July 1988, Indian Creek, a third-order stream in Butler County, Ohio, ceased flowing at a site, forming a series of isolated pools. Responses of 14 species of fish were observed in

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two shallow (< 20 cm) pools, when maximum water temperatures reached 38.3 to 39.5 °C. Individuals of 12 species died from thermal stress in one pool. Despite occurrence of these high water temperatures on at least two separate dates, individuals of 4 (of 12) and 14 (of 14) species of fish survived in the two pools, respectively. Mean critical thermal maxima (CTM) of six species of fish (striped shiner *Notropis chrysophealus*, silverjaw minnow *Ericymba buccata*, bluntnose minnow *Pimephales notatus*, central stoneroller *Campostoma anomalum*, quillback carpsucker *Carpodacus cyprinus*, fantail darter *Etheostoma flabellare*) collected from one of the pools after exposure to the high temperatures ranged from 36.2 to 38.8 °C. Survival of fish in the pools was attributed to their elevated thermal tolerances (CTMs), and the use of shaded cooler refugia in each pool. (Author's abstract) W90-05310

LIFE HISTORY OF ANADROMOUS COASTAL CUTTHROAT TROUT IN SNOW AND SALMON CREEKS, JEFFERSON COUNTY, WASHINGTON, WITH IMPLICATIONS FOR MANAGEMENT.

Snow Creek Research Station, Port Townsend, WA.
J. H. Michael.
California Fish and Game CAGAX, Vol. 75, No. 4, p 188-203, 1989. 1 fig, 4 tab, 29 ref.

Descriptors: *Trout, *Anadromous fish, *Life history studies, *Fish populations, *Stream fisheries, *Survival, *Smolt, *Fish migration, *Washington.

In recent years, angler effort directed at anadromous cutthroat trout has increased and biologists have become concerned about the health of impacted populations. In addition, limited research had been done on anadromous cutthroat, providing incomplete information on which to base management decisions. The Washington Department of Wildlife established a field station at Snow Creek in 1976 which subsequently provided an opportunity to obtain life history data on anadromous and resident cutthroat trout. Upstream and downstream migrations of anadromous coastal cutthroat trout adults, subadults, and smolts were trapped and enumerated at Snow Creek Research Station (Jefferson County, WA) between 1975 and 1985. Survivals of adults and subadults in freshwater were calculated as well as the survival of smolts in saltwater. Results were then compared with values generated from other studies. The anadromous cutthroat in Snow and Salmon creeks represent a late-entry stock with upstream migration peaking between January and April. Overwinter survival of adults and sub-adults in freshwater ranged from 22.2% to 76.9% and appeared related to winter temperature and flow regimes in the stream. Marine survival from smolt to first return to freshwater were too low to maintain the maximum smolt population observed. (Author's abstract) W90-05322

TEMPORAL AND SPATIAL VARIATION IN PELAGIC FISH ABUNDANCE IN LAKE MEAD DETERMINED FROM ECHOGRAMS.

Nevada Univ., Las Vegas. Lake Mead Limnological Research Center.
G. R. Wilde, and L. J. Paulson.
California Fish and Game CAGAX, Vol. 75, No. 4, p 218-223, 1989. 3 fig, 1 tab, 17 ref.

Descriptors: *Echograms, *Sounding, *Fish populations, *Reservoir fisheries, *Lake Mead, *Shad, *Temporal distribution, *Population density, *Seasonal variation, *Spatial distribution, *Chlorophyll a, *Statistical analysis, *Correlation analysis, *Lake fisheries, *Arizona, *Nevada.

In freshwater, echograms have been used to describe vertical, spatial and temporal patterns in fish abundance. A procedure used for the scoring and statistical analysis of echograms as relative estimates of pelagic fish abundance, by reporting temporal and spatial variation in pelagic fish abundance in Lake Mead was developed. Echograms were scored on a scale of 1 to 5 and used as relative estimates of pelagic fish abundance in Lake

Mead, Arizona-Nevada. Spatial and temporal patterns in fish abundance and the association between fish abundance and chlorophyll a concentration were tested with nonparametric statistical methods. No difference was found in fish abundance between the years of the study (March 1981 through December 1982; $p = 0.5017$), but there was significant seasonal ($p = 0.0068$) and spatial ($p < 0.0001$) heterogeneity in abundance. Fish abundance was greatest in the summer, following the threadfin shad spawn in March-June; abundance declined during fall and winter, but there was no change from winter to spring. Fish abundance was positively correlated with chlorophyll a concentration ($r_{sub s} = 0.533$, $p < 0.0001$). (Author's abstract) W90-05324

BIOACCUMULATION OF CINMETHYLIN IN BLUEGILL SUNFISH.

Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Agricultural Products Dept.
For primary bibliographic entry see Field 5C.
W90-05327

FISHERY IN NATURE RESERVES (FISCHEREI IN NATURSCHUTZGEBIETEN).

Landesamt fuer Wasserwirtschaft Rheinland-Pfalz, Mainz (Germany, F.R.).
B. W. Scharf.

Zeitschrift fuer Wasser- und Abwasser Forshung ZWABAQ, Vol. 22, No. 6, p 235-239, December 1989. 1 tab, 19 ref. English summary.

Descriptors: *Fisheries, *Recreation, *Environmental effects, *Ecological effects, *Food chains, *Ecosystems, *Fish stocking, *Wildlife conservation, *Wildlife management.

The negative effects of fisheries on the ecosystem of lakes in nature reserves include deterioration of shore vegetation, effects of manuring, fish-feeding, fish stocking and other disturbances of the natural food web. The conflict of sport fishery vs. nature conservation is enhanced by the increased leisure demands of the people. The impact of recreation on natural waters can be diminished by ensuring that fishermen are well informed, by reducing fishing intensity, and providing alternative waters for recreation. The relation of predatory fish to cyprinids should be well balanced. Lakes should be investigated at regular intervals by fish experts. To maintain an extensive fishery, only the natural yield of the lake should be caught thus preserving the natural ecosystem. (Geiger-PTT) W90-05417

FISHES OF NORTH AMERICA ENDANGERED, THREATENED, OR OF SPECIAL CONCERN: 1989.

Bureau of Land Management, Washington, DC. Endangered Species Committee.
J. E. Williams, J. E. Johnson, D. A. Hendrickson, S. Contreras-Balderas, and J. D. Williams.
Fisheries (Bethesda) FISHDN, Vol. 14, No. 6, p 2-20, November/December 1989. 4 plates, 2 tab, 54 ref, append.

Descriptors: *Endangered species, *Fish management, *Fish populations, *North America, *Extinction, *Classification, *Recovery efforts, *Habitats, *Ecosystems.

The American Fisheries Society provides an update of their now decade-old list of rare North American fishes. The 1989 list adds 139 new taxa to the list developed in 1979 of 251 fishes and removes 26 for a total of 364 fishes in Canada, United States, and Mexico that warrant protection because of their rarity. The 26 taxa removed from the 1979 list include 16 removed because of better information on their taxonomy or status and 10 because they have become extinct. Not a single fish warranted removal from the list because of successful recovery efforts. In addition, 49 fishes have changed in status but remain on the list: 7 have improved in status, 24 have declined, and 18 have been reclassified because new information revealed that they were either more common or rarer than was earlier believed and, therefore, were

incorrectly classified in 1979. Comparison of the 1979 and 1989 lists indicates that recovery efforts have been locally effective for some species, but are clearly lagging behind deterioration of the overall fish fauna. The health of aquatic habitats in North America continues to decay. A major commitment to conservation of entire ecosystems, rather than the inconsistent recovery efforts for individual species, is needed to reverse this trend. (Author's abstract) W90-05448

EXTINCTIONS OF NORTH AMERICAN FISHES DURING THE PAST CENTURY.

Michigan Univ., Ann Arbor. Museum of Zoology.
R. R. Miller, J. D. Williams, and J. E. Williams.
Fisheries (Bethesda) FISHDN, Vol. 14, No. 6, p 22-38, November/December 1989. 10 fig, 2 tab, 101 ref, append.

Descriptors: *Fish management, *Fish populations, *Extinction, *Endangered species, *North America, *Habitats, *Ecosystems, *History.

Extinctions of 3 genera, 27 species, and 13 subspecies of fishes from North America are documented during the past 100 years. Extinctions are recorded from all areas except northern Canada and Alaska. Regions suffering the greatest loss are the Great Lakes, Great Basin, Rio Grande, Valley of Mexico, and Pecos Valley in Mexico. More than one factor contributed to the decline and extinction of 82% of the fishes. Physical habitat alteration was the most frequently cited causal factor (73%). Detrimental effects of introduced species also were cited in 68% of the extinctions. Chemical habitat alteration (including pollution) and hybridization each were cited in 38% of the extinctions, and overharvesting adversely affected 15% of the fishes. This unfortunate and unprecedented rate of loss of the fishery resource is expected to increase as more of the native fauna of North America becomes endangered or threatened. (Author's abstract) W90-05449

RESPONSE OF JUVENILE STEELHEAD TO INSTREAM DEFLECTORS IN A HIGH GRADIENT STREAM.

Humboldt State Univ., Arcata, CA. Dept. of Fisheries.

J. B. Hamilton.

IN: Practical Approaches to Riparian Resource Management: An Educational Workshop. American Fisheries Society, Bethesda, MD. 1989. p 149-158. 2 fig, 7 tab, 56 ref.

Descriptors: *Land management, *Water resources management, *Water law, *Stream fisheries, *Stream stabilization, *Fish management, *Fish populations, *Stream improvement, *Steelhead, *Salmon, *Streamflow, *Wildlife habitats, *California, *Deflectors.

Stream channel characteristics and juvenile steelhead *Oncorhynchus mykiss* populations were estimated before and after placement of boulder/rock triangular wing deflectors in 10 sections of a northern California stream in an effort to improve rearing habitat. An equal number of control sections were monitored. Following winter flows in 1981-1982, 14% of the structures were functionally intact. Changes in fry and parr numbers, densities, biomass, and standing crops in treated sections were not significantly different from changes in control sections. Condition factor of parr in 1982 was significantly reduced in treated sections following winter flows. A significantly lower percentage of marked parr remained in treatment sections following alteration. A review of similar habitat improvement evaluations indicated projects that increase populations have usually been sited on lower gradient (mean of 1.0%) stream reaches. Projects that did not demonstrate population increases were generally on higher gradient (mean of 1.8%) stream reaches, and results, although valuable, are less frequently published. (See also W90-05491) (Author's abstract) W90-05513

Field 8—ENGINEERING WORKS

Group 81—Fisheries Engineering

RESERVOIR FISHERIES MANAGEMENT: STRATEGIES FOR THE 80'S.

Proceedings of a Symposium held in Lexington, Kentucky, June 13-16, 1983. American Fisheries Society, Bethesda, MD. 1986. 327p. Edited by Gordon E. Hall and Michael J. Van Den Avyle.

Descriptors: *Reservoir fisheries, *Reservoir design, *Reservoir operation, *Reservoir releases, *Reservoirs, *Conferences, Multipurpose reservoirs, Fish management, Fish populations, Fish stocking, Fisheries, Fish, Fish establishment, Management planning.

Reservoirs constitute one of our most valuable fishery resources—a resource that is exceedingly complex, poorly understood, and crudely managed. As such, reservoirs continue to provide major fishery management problems and, consequently, offer tremendous opportunities for improvement. A symposium was held in Lexington, Kentucky, on June 13-16, 1983 to explore management of reservoir fisheries. Specific objectives of the symposium were (1) to provide a critical assessment of current practices for managing reservoir fisheries; (2) to provide a forum for the exchange of information and ideas among users and managers of reservoir fishery resources; (3) to stimulate new ideas and approaches for managing reservoir fishery resources; (4) to identify critical research and management needs; and (5) to clarify the role of fishery management relative to reservoir planning, operation, and other recreational uses. This compilation from the symposium includes technical papers on development of management programs and measurement of economic values, assessment of fish populations and measurement of angler harvest, management of the physical and chemical environment, management of reservoir fish communities by influencing species interactions and by harvest regulation, management implications of energy development and management of reservoir releases. Abstracts of poster presentations focus on harvest regulation and reservoir stocking. (See W90-05515 thru W90-05531) (Mertz-PTT) W90-05514

SIMULATION MODEL FOR MANAGING FISHERIES IN RESERVOIRS ON THE RIO GRANDE OF NEW MEXICO.

New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences. R. Cole, T. Ward, F. Ward, and R. Deitner. IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 18-27. 5 fig, 2 tab, 20 ref.

Descriptors: *Mathematical models, *Reservoir fisheries, *Texas, *Reservoirs, *Reservoir operation, *Fish populations, *Fish management, Reservoir storage, Rivers, Zooplankton, Benthos, Economic aspects, Fishing.

A mathematical model of the upper Rio Grande system above El Paso, Texas is being constructed to predict biological and economic consequences of alternatives for managing river flow through six reservoirs and their connecting waters. The hydrologic component of the model simulates inputs of water, suspended sediments, and limiting plant nutrients to reservoirs which, in turn, alter reservoir water level, depth of light penetration, and concentration of limiting nutrients. The biological component uses the simulated fluctuations of water levels and material loadings as well as meteorological data, including solar radiation, to determine flows of energy and materials through aquatic plants, intermediate consumers, and fish. Fish production is partitioned into groups that feed primarily on zooplankton, zoobenthos, and fish, and occupy five different habitats based on levels of illumination. The economic component requires predicted estimates of fish production and water-level changes as well as user travel costs, income, fishing success rates, and population distribution. A recreational use-projection and dollar-benefit prediction model has been developed, which includes an empirically determined relationship between fish yield, fishing effort, and economic benefits. The model will be useful for (1) improved predictions of fluctuations that cause reproductive failure, productivity

changes or predator/prey imbalances; (2) development of alternative water management plans that increase fish reproductive success; (3) assessing the value of water for improved fisheries; and (4) influencing policy or program decisions that affect the water quality or structure of the river system. (See also W90-05514) (Mertz-PTT) W90-05515

MANAGEMENT OF FISHERIES ON LARGE AFRICAN RESERVOIRS—AN OVERVIEW.

Food and Agriculture Organization of the United Nations, Rome (Italy). Fishery Resources and Environment Div. J. M. Kapetsky.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 28-38. 1 fig, 3 tab, 40 ref.

Descriptors: *Reservoir fisheries, *Africa, *Reservoirs, *Economic aspects, *Fish harvest, *Fish management, Fish populations, Fish, Reservoir operation, Fishing, Reservoir yield.

Reservoirs provide about 10% of the 1.4 million tons of fish harvested annually from Africa's inland waters. The cumulative surface area of African reservoirs exceeds 40,400 square km. The predominant resources in these reservoirs are tilapias. Yields in the larger reservoirs under moderate to heavy fishing pressure currently vary from about 27 to 65 kg/hectare/year. Many African countries are food-poor, and much of the available labor force is underemployed; therefore, African reservoir fisheries are managed primarily to produce food fishes and to create employment. Fisheries are labor intensive rather than mechanized and are little regulated. Introduction of non-indigenous species has been a successful management technique for the development of littoral and pelagic fisheries. Development of reservoir fisheries has included a wide variety of activities—brush and tree clearing; boat building; training in fishing methods; improvement of processing techniques; establishment of water and road transport systems; market facilities; and organization of fishermen's cooperatives and credit schemes. (See also W90-05514) (Author's abstract) W90-05516

MANAGEMENT OF THE PHYSICAL AND CHEMICAL ENVIRONMENT: EFFECTS OF WATER-LEVEL CHANGES ON RESERVOIR ECOSYSTEMS, WITH IMPLICATIONS FOR FISHERIES MANAGEMENT.

Aquatic Ecosystem Analysts, Fayetteville, AR. G. R. Ploskey.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 86-97. 104 ref.

Descriptors: *Reservoir fisheries, *Reservoir releases, *Fish management, *Reservoir operation, Fish, Fish populations, Management planning, Reservoirs, Water level, Model studies.

Over 350 papers published since 1930 compose the extensive literature about effects of water-level changes on aquatic biota. Most of the literature details single pre-treatment and post-treatment studies evaluating effects on species of plants, invertebrates, or fish. Although some conflicting results have been obtained, fishery managers have developed successful management plans by relying on the consensus of published observations. Most managers seek to (1) draw down water levels in late summer or fall, (2) establish terrestrial vegetation by seeding or allowing for recolonization, (3) flood vegetation in spring, and (4) maintain high water for as much of the growing season as possible. Variations of this general plan, with regard to magnitude, duration, and timing have been used, but the literature suggest that only broad manipulations on seasonal or annual time scales yield significant benefits. Long-term data replicating several management and recruitment events are needed to develop predictive models. Comprehensive models probably are lacking today because manipulation and evaluation are expensive multi-year efforts. However, sound predictions will become increasingly important to justify future requests for mod-

fied reservoir operations. (See also W90-05514) (Author's abstract) W90-05517

MODIFYING RESERVOIR FISH HABITAT WITH ARTIFICIAL STRUCTURES.

Tennessee Valley Authority, Knoxville. A. M. Brown.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 98-102. 25 ref.

Descriptors: *Reservoir fisheries, *Fish management, *Fishing, *Reservoir operation, Fish attractors, Fish, Fisheries, Reservoirs, Vegetation, Timber, Tires, Illumination.

Artificial structures, mainly fish attractors, have been used for many years to enhance sport fishing. The effects of attractor installation were first reported in 1931. Since that time, the art of fish attractor installation and evaluation has evolved into a variety of useful techniques, many of which remain to be evaluated or still need improvement. Fish attractors can be categorized by the type of material used. The major ones are (1) brush, (2) automobile tires, (3) stake beds, (4) standing timber, and (5) shoreline vegetation. Many other materials have been used including gravel beds, log cribs, flue tile, and precast concrete forms. Techniques of structure installation need to be evaluated. The possibility of concentrating different desired fish species by using a combination of dissimilar attractor types and installation procedures has not been explored. Practices such as artificial baiting, attraction with underwater lights, environmentally safe dyes that provide shading in clear water lakes, sound waves, bubble curtains, pheromones, and cage culture of catfish (which often attracts wild fish) are some of the possible new areas for investigations in fish attraction and concentration. (See also W90-05514) (Mertz-PTT) W90-05518

REVIEW OF WATER LEVEL MANAGEMENT ON KANSAS RESERVOIRS.

Kansas Fish and Game Commission, Emporia. D. W. Willis.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 110-114. 1 fig, 4 tab, 14 ref. Federal Aid Project FW-9-P-2.

Descriptors: *Reservoir operation, *Reservoir fisheries, *Reservoir releases, *Fish management, *Kansas, *Water level fluctuations, *Water level, Fisheries, Transparency, Fish populations, Walleyes, Bass, Crappie, Vegetation.

Water level management plans in Kansas typically consist of a spring rise to flood terrestrial vegetation, a summer drawdown of approximately 4 ft to allow regrowth of vegetation and concentrate predators and prey, an autumn rise of approximately 2 ft to flood some terrestrial vegetation and attract waterfowl, and a winter drawdown to again concentrate predators and prey and protect remaining vegetation from water damage. Netting data indicate that this program has increased population densities of walleye (*Stizostedion vitreum*), white crappie (*Pomoxis annularis*), and white bass (*Morone chrysops*) in impoundments where 20% or more of the basin area was exposed during drawdown. Largemouth bass (*Micropterus salmoides*) densities were negatively impacted, presumably because of the reduction of vegetative habitat resulting from mid-summer drawdown. Water transparencies typically increased with use of this water level management plan. (See also W90-05514) (Author's abstract) W90-05520

EFFECTS OF ENVIRONMENTAL FACTORS ON GROWTH OF LARGEMOUTH BASS IN TEXAS RESERVOIRS.

Texas Parks and Wildlife Dept., Ingram. Heart of the Hills Research Station. For primary bibliographic entry see Field 2H. W90-05521

Fisheries Engineering—Group 81

SPATIAL HETEROGENEITY IN FISH PARAMETERS WITHIN A RESERVOIR.

Duke Power Co., Huntersville, NC. Production Environmental Services.

J. R. Siler, W. J. Foris, and M. C. McNerny.
IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 122-136. 4 fig, 77 tab, 49 ref.

Descriptors: *Reservoir fisheries, *Fish populations, *Bass, *Crappie, *Shad, *Reservoir operation, Fish, Fish harvest, Fish management, Phosphorus, Sport fishing, Chlorophyll, Model studies, Physical properties, Chemical properties, Management planning.

Various components of the Lake Norman fish community exhibited spatial heterogeneity. Harvest of sport fish exhibited a longitudinal trend within the reservoir as did total phosphorus and chlorophyll a concentration. Harvest of largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* spp.), striped bass (*Morone saxatilis*), and white bass (*Morone chrysops*) was lowest at the most downlake area (3 kg/hectare), increased steadily to the uplake riverine area (51 kg/hectare), and was highest at the discharge of a steam-electric station (316 kg/hectare). Fishing pressure varied similarly. Threadfin shad (*Dorosoma petenense*) standing stocks in October exhibited a longitudinal gradient that was similar to the gradient observed for phytoplankton standing crop. Interreservoir predictive models did not account for the intrasystem variability in fish parameters, most likely because the models failed to consider the heterogeneity of habitat and physicochemical variables within the reservoir. The existence of heterogeneity in fish parameters indicates that management decisions based on data collected from one or two stations within the reservoir could be erroneous and that managing the reservoir as a biological entity may be ineffective. An understanding of gradients within reservoirs would help managers collect representative samples with improved precision. Spatial heterogeneity in fish standing stock, harvest, and mortality in Lake Norman indicates that the potential of the fishery is not realized because of species-specific habitat and physical constraints. Density-independent mortality appeared to regulate the biomass of striped bass and threadfin shad in the reservoir because of their relatively narrow thermal requirements. Removal of these constraints would allow the system to become regulated by density-dependent phenomena, thus improving the efficiency and stability of the system. (See also W90-05514) (Author's abstract)
W90-05522

FISHERY MANAGEMENT IN COOLING IMPOUNDMENTS.

Duke Power Co., Huntersville, NC. Production Environmental Services.

L. L. Olmsted, and J. P. Clugston.
IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 227-237. 1 fig, 52 ref.

Descriptors: *Cooling ponds, *Powerplants, *Reservoir fisheries, *Fish management, *Reservoir operation, *Waste heat, Reservoir design, Reservoir siting, Reservoir construction, Reservoirs, Fish, Fishing, Fisheries, Water temperature, Thermal pollution, Heated water, Temperature effects.

Impoundments constructed primarily for the dissipation of waste heat from powerplants represent a unique aquatic habitat. Although cooling impoundments typically support substantial fisheries, increasing fishing demand dictates that these impoundments be managed productively. Virtually all fishery management techniques used in non-cooling lakes and reservoirs can be applied to cooling impoundments with only minor modifications. Numerous additional management options unique to cooling impoundments are available as a result of the pumping and heating of large quantities of water. These options range from altering stocking strategies to capitalize on the altered thermal regime to attempting to influence water quality and nutrient availability by controlling mixing patterns. For cooling impoundments to be excel-

lent fisheries, certain management options need to be considered when siting, designing, constructing and operating the facilities; these include: (1) fisheries should be an integral consideration in siting and design phases of project development; (2) formal fishery management plans need to be developed for each cooling impoundment; (3) although most states maintain responsibility for management, the responsibility for monitoring fisheries can be shared by the utility; (4) research is needed to evaluate techniques for increasing fish yield; (5) closure of impoundments to the public is often implemented for safety reasons; safety can be enhanced by instituting relatively inexpensive physical modifications or selectively restricting access; (6) regulatory agencies that work to reduce adverse effects from cooling impoundments could use monitoring of heat load to maximize fish production; and (7) dialogue among fishery biologists, limnologists, engineers, and regulators would open up innovative options for increasing fish yields. (See also W90-05514) (Mertz-PTT)
W90-05523

OVERVIEW OF RESERVOIR FISHERIES PROBLEMS AND OPPORTUNITIES RESULTING FROM HYDROPOWER.

Sport Fishing Inst., Washington, DC.

N. S. Prosser.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 238-246. 63 ref.

Descriptors: *Powerplants, *Hydroelectric plants, *Reservoir fisheries, *Fish management, *Reservoir operation, Fish migration, Legal aspects, Water law, Environmental protection, Environmental policy, Fisheries.

Interest in hydropower in the United States is undergoing a resurgence, and some 1900 sites have been identified for new hydropower development. Hydropower facilities affect fisheries by creating impoundments, imposing migration barriers, and by altering physico-chemical characteristics and biota of impounded water. Opportunities for recreational fisheries development are commonly associated with hydropower impoundments. Fisheries biologists must prepare management recommendations with an understanding of operational impacts on fish passage, reproduction, and survival. The Pacific Northwest Electric Power Planning and Conservation Act, passed in December 1980, mandates the conservation and restoration of the Columbia River Basin's fish and wildlife resources that have been adversely affected by hydroelectric development and operations. This congressionally mandated guidance for responsible natural resources management, including fisheries, should serve as a protocol leading to similar commitments by the hydropower industry throughout the country. (See also W90-05514) (Mertz-PTT)
W90-05524

FISHERIES PROBLEMS ASSOCIATED WITH THE TRUMAN DAM PUMPED STORAGE HYDROELECTRIC PROJECT IN WEST CENTRAL MISSOURI.

Missouri Dept. of Conservation, Columbia.

K. R. Richards, R. J. Dent, and W. H.

Dieffenbach.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 247-254. 2 fig, 26 ref.

Descriptors: *Powerplants, *Hydroelectric plants, *Reservoir fisheries, *Fish management, *Fish migration, Truman Dam, Lake of the Ozarks, Chemical properties, Reservoir operation, Dams, Barriers, Fish, Fish passages, Fisheries.

Harry S. Truman Dam was completed in 1977 to provide flood control, recreation, and pumped storage hydropower production. An excellent tailwater fishery developed immediately below Truman Dam; however, problems associated with the project have adversely impacted many aspects of the fishery of Lake of the Ozarks. Spawning migrations of several species have been blocked, and reproductive success of species able to spawn downstream from the dam has been affected by

water level fluctuations and variable flows. Fish kills have occurred due to gas supersaturation, low dissolved oxygen concentrations, and periodic dewatering of the turbine draft tubes for maintenance purposes. Mortality caused by pumpback also is a severe problem. Less obvious, long-term impacts of the operation of Truman Dam are also being studied. Placement of this type of pumped storage hydroelectric facility between two large warm-water reservoirs is unique. Hopefully, fishery problems documented at the Truman Dam project can be avoided in future energy development projects. (See also W90-05514) (Author's abstract)
W90-05525

MANAGEMENT OF LARGEMOUTH BASS IN A PERCHED COOLING POND IN ILLINOIS.

Illinois Power Co., Clinton. Clinton Power Station.

J. A. Smithson, K. F. Kurzwaski, and T. V.

Clevenger.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 255-260. 1 fig, 4 tab, 21 ref.

Descriptors: *Cooling ponds, *Reservoir fisheries, *Fish populations, *Bass, *Temperature effects, *Powerplants, *Shad, Reservoir discharge, Water temperature, Illinois, Reservoirs, Fish harvest, Growth, Fish management.

A population of largemouth bass (*Micropterus salmoides*) in a perched cooling pond in Illinois (Baldwin Cooling Pond) was monitored by electrofishing from 1979 through 1982. The population was characterized by seasonal movements in response to thermal discharges, rapid growth, and a high proportion of young-of-the-year and Age-1 fish. During winter months, catch rates of largemouth bass were 90% higher in the discharge canal than at mid-lake or at the power plant intake. Catch rates declined in the discharge canal during the summer and increased again in the fall. Mean lengths attained by young-of-the-year (232 mm) and yearling largemouth bass (355 mm) by December were similar to the highest growth rates reported in the literature. Rapid growth is attributed to the general interaction of temperatures optimum for growth and establishment of an overwintering threadfin shad (*Dorosoma petenense*) population. The young-of-the-year and Age-1 fish accounted for more than 86% of the largemouth bass collected during August-December of each year. The combination of insufficient recruitment and overharvest of Age-2 and older fish contributed to the imbalanced age structure. Management strategies for largemouth bass are discussed in relation to unique characteristics of perched cooling ponds. (See also W90-05514) (Author's abstract)
W90-05526

MANAGEMENT OF RESERVOIR RELEASES: IMPROVING THE DOWNSTREAM ENVIRONMENT BY RESERVOIR RELEASE MODIFICATIONS.

Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.

R. J. Ruane, C. E. Bohac, W. M. Seawell, and R. M. Shane.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 270-277. 1 tab, 46 ref.

Descriptors: *Water quality management, *Powerplants, *Reservoir fisheries, *Fish management, *Reservoir operation, Tailwater, Dams, Aeration, Sluices, Hydroelectric plants, Reservoir releases, Physical properties, Chemical properties, Fisheries, Fish, Environmental protection.

Tailwater fisheries can be adversely impacted by reservoir releases, but engineering modifications can significantly improve them. Physical and chemical factors that can affect tailwater fisheries include low dissolved oxygen, changes in temperature, supersaturation of total dissolved gases, dissolved chemical substances such as iron, manganese, hydrogen sulfide, and ammonia, and low streamflow. Tailwaters usually are affected by only

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a few of these factors. Each tailwater is uniquely affected depending on upstream reservoir operations, the water quality of the reservoir releases, and tailwater characteristics. Methods that have been demonstrated to improve tailwater fisheries include aeration of the hypolimnion in the upstream impoundment, destratification of the upstream impoundment, hydroturbine aeration, tailrace aeration, multi-level intakes for the upstream reservoir, sluicing, modified reservoir operations, and regulation of the present hydropower releases. Few of these methods have been applied on a widespread basis; therefore, experience with these techniques is limited, and associated fishery benefits have not been adequately documented. (See also W90-05514) (Author's abstract) W90-05528

ENHANCING TAILWATER FISHERIES.

Bureau of Reclamation, Denver, CO. Engineering and Research Center.

J. C. Peters.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 278-285. 2 tab, 21 ref.

Descriptors: *Tailwater, *Reservoir fisheries, *Fish management, Reservoir releases, Fish, Management planning, Hydrology, Geomorphology, Research priorities.

The most important physical constraints on tailwater fisheries are hydrology, land use, geomorphology, and water quality. The amount of water released constitutes the most fundamental restriction on the range of management and allocation options available to decision-makers. It is essential to balance the need for healthy environments for reservoir and tailwater fisheries. To do this fish biologists must (1) document where there have been successes on new projects or where existing projects have been successfully modified and (2) identify legislative needs to correct longstanding problems related to tailwater fisheries. To enhance tailwater fisheries researchers need to improve life history information for warm and cool water fishes in rivers, develop more effective fish sampling techniques in tailwaters, increase their knowledge on interspecific competition, publish case histories documenting successful management of tailwater fishes, and develop and implement project operational criteria affecting tailwater fisheries. Recommendations for future action include setting standards, developing guidance documents, and carrying out environmental quality assurance programs. (See also W90-05541) (Mertz-PTT) W90-05529

EFFECT OF A HYPOLIMNETIC DISCHARGE ON REPRODUCTIVE SUCCESS AND GROWTH OF WARMWATER FISH IN A DOWNSTREAM IMPOUNDMENT.

Tennessee Valley Authority, Norris. Office of Natural Resources.

G. D. Hickman, and K. W. Hevel.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 286-293. 2 fig, 4 tab, 8 ref.

Descriptors: *Reservoir releases, *Dam effects, *Fish populations, *Reservoir fisheries, *Growth, Rotenone, Bass, Fish management, Hypolimnion, Plankton, Ichthyoplankton, Larvae, Reservoirs, Water temperature, Fish reproduction.

Cove rotenone samples (1972-1982), electrofishing samples (1975-1977), and ichthyoplankton samples (1975-1976) in Melton Hill Reservoir were compared with water release rates from upriver Norris Dam to determine impacts of a hypolimnetic discharge on fish reproductive success and growth of largemouth bass (*Micropterus salmoides*) in a downstream impoundment. A significant inverse relationship was found between water volume discharge during spring and early summer from Norris Dam and same-year estimates of young-of-year numbers from cove rotenone samples. Larval fish samples revealed low diversity and densities in 1975, when spring discharges were high, and much higher levels in 1976, when spring discharges were low. Cove rotenone data showed similar increases

of 2938% in clupeid numbers and 309% in centrarchids from 1975 to 1976. Largemouth bass (Age 1) grew significantly faster and had higher young-of-year production during years of low spring releases from Norris Dam and slower growth and low young-of-year production during years of high spring discharges. Variable reservoir temperature regimes that resulted from yearly differences in spring and early summer discharge rates produced significant variations in spawning success of warm water species and growth of piscivorous sport fish. (See also W90-05514) (Author's abstract) W90-05530

WALLEYE MIGRATION THROUGH TYGART DAM AND ANGLER UTILIZATION OF THE RESULTING TAILWATER AND LAKE FISHERIES.

West Virginia Dept. of Natural Resources, Fairmont. Div. of Wildlife Resources.

F. Jernejcic.

IN: Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, MD. 1986. p 294-300. 6 tab, 11 ref.

Descriptors: *Powerplants, *Fish populations, *Reservoir fisheries, *Hydroelectric plants, *Walleyes, *Fishing, Dams, West Virginia, Fish management, Tailwater, Fish, Reservoirs, Fish migration, Environmental impact statement, Dam effects, Sport fishing, Tygart Lake, Environmental effects.

Fish populations in 1740-acre Tygart Lake, West Virginia and its tailwater were sampled to provide information needed to evaluate impacts associated with the addition of hydropower facilities to the Tygart Lake projects. Walleyes (*Stizostedion vitreum vitreum*) dominate the sport fishery of the lake and migrate through the dam, providing a major tailwater fishery. Anglers caught 6042 walleyes from the lake and 8724 from the tailwater during a 1-year period. Walleye fishing success was higher in the tailwater than in the lake (0.56 vs. 0.32 caught per hour). Walleye fishing success was highest during the fall in the lake but during the spring in the tailwater. Tag returns indicated a 6% exploitation rate for lake walleyes during a 15-month period. Tailwater walleyes experienced a 25% exploitation rate during a 7-month period. Nine percent of walleyes tagged in the lake were caught by anglers in the tailwater from December through March. Age-0 and Age-1 walleyes migrated through the dam more readily than older walleyes. Walleye migration occurred during the winter, December through April, at times when the pool elevation was decreasing at a rate of at least 6-ft per 24 hours. (See also W90-05514) (Author's abstract) W90-05531

LARVAL FISH AND SHELLFISH TRANSPORT THROUGH INLETS.

Proceedings of a Workshop Held in Ocean Springs, Mississippi, August 19-20, 1985. American Fisheries Society, Bethesda, MD. 1988. Symposium 3. 165p. Edited by Michael P. Weinstein.

Descriptors: *North Carolina, *Conferences, *Larvae, *Inlets, *Jetties, Fish, Fish larvae, Shellfish, Shellfish larvae, Coastal engineering, Larval transport, Flow, Alteration of flow, Flow measurement.

The Larval Transport Workshop was convened to reexamine the technical foundation of the transport issue as it pertains to jetty projects. The objective was to summarize the present state of knowledge regarding transport processes, because there were no existing data sets specifically on the subject. The collection of papers in this volume are from the workshop, held at the Gulf Coast Research Laboratory in Ocean Springs, Mississippi, on August 19-20, 1985. Long-standing questions regarding the effects of coastal engineering projects, particularly construction of jetties at coastal inlets, on the recruitment of egg and larval stages of fishes and shellfishes are addressed. Thirteen peer-reviewed papers examine topics such as transport of water masses and larvae from the continental shelf to inlets, transport processes and mechanisms

immediately in and around inlets, general physical oceanographic processes affecting larval fish transport in North Carolina inlets, recruitment process for larvae passage, behavioral tactics and physical factors that cue larvae during passage from spawning to nurturing ground and the relative roles of passive and active transport. (See W90-05533 thru W90-05545) (Mertz-PTT) W90-05532

TRANSPORT MODEL FOR WATER EXCHANGE BETWEEN COASTAL INLET AND THE OPEN OCEAN.

State Univ. of New York at Stony Brook. Marine Sciences Research Center.

For primary bibliographic entry see Field 2L. W90-05534

OBSERVATIONS ON INLET FLOW PATTERNS DERIVED FROM NUMERICAL AND PHYSICAL MODELING STUDIES.

Coastal Engineering Research Center, Vicksburg, MS.

For primary bibliographic entry see Field 2L. W90-05535

PHYSICAL OCEANOGRAPHIC PROCESSES AFFECTING LARVAL TRANSPORT AROUND AND THROUGH NORTH CAROLINA INLETS.

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.

For primary bibliographic entry see Field 2L. W90-05537

ROLES OF BEHAVIORAL AND PHYSICAL FACTORS IN LARVAL AND JUVENILE FISH RECRUITMENT TO ESTUARINE NURSERY AREAS.

National Marine Fisheries Service, Honolulu, HI. Honolulu Lab.

For primary bibliographic entry see Field 2L. W90-05538

PHYSICAL PROCESSES AND THE MECHANISMS OF COASTAL MIGRATIONS OF IMMATURE MARINE FISHES.

North Carolina State Univ. at Raleigh. Dept. of Zoology.

For primary bibliographic entry see Field 2L. W90-05539

POPULATION DYNAMICS OF SMALL-MOUTH BASS (*MICROPTERUS DOLOMIEU*) IN THE GALENA (FEVER) RIVER AND ONE OF ITS TRIBUTARIES.

Wisconsin Dept. of Natural Resources, Madison.

For primary bibliographic entry see Field 2H. W90-05611

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

PERSPECTIVES ON WATER RESOURCES EDUCATION AND TRAINING.

Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 1, p. 99-133, January/February 1990. 30 tab, 3 ref, 2 append.

Descriptors: *Civil engineering, *Engineering, *Education, Surveys, Training, Professionals.

An ASCE Task Committee conducted an opinion survey of 563 engineering professionals on the adequacy of current educational programs in water resources engineering. Where the responses of practicing professionals and educators differed, separate tables present the opinions of both groups. The respondents call for many refinements and changes of emphasis and scope in current undergraduate, graduate, and continuing education pro-

Grants, Contracts, and Research Act Allotments—Group 9D

grams. Specific recommendations include greater emphasis upon knowledge and skills that are important in practice, improvement of communication skills at all levels, and increasing the breadth of degree programs. Recommendations for strengthening entrance requirements for the profession are included, and a call is made for institutional adjustments that are necessary for those in practice to update their education and training. Respondents want the ASCE to continue to stimulate interaction and discussion that will lead to refinement and improvement of educational and training programs. (Author's abstract)
W90-05305

9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1988 PROGRAM REPORT (VERMONT WATER RESOURCES RESEARCH INSTITUTE).
Vermont Water Resources Research Center, Burlington.

A. W. McIntosh.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119637/AS. Price codes: A03 in paper copy, A01 in microfiche. School of Natural Resources, Report No. G1594-01, July 1989. 25p. USGS Contract 14-08-0001-G1594. USGS Project G1594-01.

Descriptors: *Water resources institutes, *Vermont, *Research, *Training, *Information transfer, *Education, *Projects.

Both surface and groundwater issues were addressed in the FY88 Vermont Water Resources Research Center program. Two projects focused on groundwater, with one assessing techniques for reducing nitrate contamination in agricultural areas and a second comparing techniques for monitoring microbial contamination. A third project considered the role of acid deposition in the fate of aluminum in soils and water, while the final effort focused on the relationship between phosphorus and stream algal communities. Information transfer activities included a workshop on Lake Champlain issues, an annual spring meeting and the production of two newsletters in cooperation with the Vermont Extension Service. (USGS)
W90-05195

FISCAL YEAR 1988 FEDERAL PROGRAM REPORT (NEW YORK STATE WATER RESOURCES INSTITUTE).

New York State Water Resources Research Inst., Ithaca.
K. S. Porter.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119678/AS. Price codes: A03 in paper copy, A01 in microfiche. Center for Environmental Research, Program Report G1579-01, July 1989. 13p. USGS Contract 14-08-0001-G1579. USGS Project G1579-01.

Descriptors: *Water resources institutes, *Research, *Training, *New York, *Information transfer, *Education, *Projects.

A major portion of New York's FY88 annual program of water research and technology focused on nonpoint sources of water pollutants to surface water, emphasizing in-place, contaminated sediment and the delivery of new sediment and chemical contaminants to water bodies. Four federally-funded projects were conducted within this program in FY88. Two research projects were studied: (1) the biological processes by which toxic metals are immobilized and remobilized in sediments and plants; in particular, the movement of cadmium from sediments into rooted plant tissue and the water column; and (2) a methodology to model the erosion characteristics of contaminated sediments in rivers. Two projects to develop education and training materials produced: (1) a tutorial computer software about the role of microorganisms in mediating the transport and fate of contaminants in sediment and soil, (2) computer programs embodying straightforward mathematical

models of nonpoint source contaminant transport for use by local government staff. (USGS)
W90-05197

FISCAL YEAR 1988 PROGRAM REPORT (KENTUCKY WATER RESOURCES RESEARCH INSTITUTE).

Kentucky Water Resources Research Inst., Lexington.
B. J. Barfield, and D. T. Kao.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119660/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1564-01, July 1989. 25p. USGS Project G1564-01.

Descriptors: *Water resources institutes, *Kentucky, *Research, *Information transfer, *Training, *Education, *Projects.

The Annual Report of the Kentucky Water Resources Research Institute for Fiscal Year 1988 describes the problems and issues facing the Commonwealth of Kentucky. The program goals and priorities describe the areas of water resources research the Institute addressed in 1988. A synopsis of each of the four research projects funded is included. The four projects are as follows: Project 02, 'Metal Speciation and Immobilization Reactions Affecting the True Efficiency of Artificial Wetlands to Treat Acid Mine Drainage,' is studying the ability of various organic substance found in wetland areas to reduce acidity and levels of Al and Fe. Project 03, 'Effects of Aromatic Concentration on Methane Fermentation,' has recognized that phenol-degrading bacteria were more susceptible to inhibition caused by high concentrations of aromatic compounds. Project 04, 'Modeling Mass Transport in Aquifers: The Distributed Source Problem,' is looking at mathematical model solutions to horizontal and vertical infiltration. Project 05, 'Regionalization of Flood Data Using Probability Distributions and Their Parameters,' has used cluster analysis to define flood regions and flood response. The Institute's technology transfer activities for 1988 are included along with the cooperative arrangements that exist between the Institute and participating universities. Training accomplishments for Fiscal Year 1988 research projects are given in terms of category and academic level. (USGS)
W90-05198

FISCAL YEAR 1988 PROGRAM REPORT (KANSAS WATER RESOURCES RESEARCH INSTITUTE).

Kansas Water Resources Research Inst., Manhattan.
H. S. Jacobs.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-119652/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1563-01, July 1989, (revised Sept. 1989). 26p. USGS Contract 14-08-0001-G1563. USGS Project G1563-01.

Descriptors: *Water resources institutes, *Kansas, *Research, *Training, *Information transfer, *Education, *Projects.

The FY88 KWRRI research projects addressed priorities in integrated aquifer analysis, water quality, river basin management and stream-aquifer interaction. Projects in integrated aquifer analysis and stream aquifer analysis included: Stream Floodwave Propagation through the Great Bend Alluvial Aquifer: A Significant Recharge and Stream-Aquifer Mechanism; and Hydrogeology of the Dakota Aquifer in Western Kansas. Aquifer characterization is a major objective of the two studies. The project, Development of Empirical Models for the Effects of Cadmium, Lead, Manganese, and Zinc on Resident Biota in the Short Creek-Empire Lake Aquatic System, Cherokee, CO., Kansas, characterized heavy metal effects of mine-waste discharges on stream and lake biota in southeast Kansas. The study, Management of the Kansas River Basin: A Systems Approach, applied the optimization model developed in a previous study to six adjacent reservoirs. Included are the Marion, Council Grove and John Redmond reser-

voirs on the Cottonwood-Neosho rivers and the Toronto, Fall River, and Elk City reservoirs on the Verdigris River. A total of six undergraduates, six Masters, and four Ph.D. degree students participated in the 1988 program. (USGS)
W90-05199

FISCAL YEAR 1988 PROGRAM REPORT (NORTH DAKOTA WATER RESOURCES RESEARCH INSTITUTE).

North Dakota Water Resources Research Inst., Fargo.

R. C. Schnell.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-129115/AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. G1581-01, July 1988. 28p. USGS Contract 14-08-0001-G1581.

Descriptors: *Water research institute, *North Dakota, *Research, *Information transfer, *Training, *Education, *Projects.

The research projects selected for funding in FY 1988 were concerned with water quality (detection and estimation of levels of dissolved organic agents) and status of wetlands in North Dakota. The water quality projects dealt with the development of a new analytical technique using a combination of high performance liquid chromatography and electrochemical detection methods to increase selectivity and sensitivity of pesticide concentrations. Another project was concerned with climatic factors (soil pH, moisture, temperature) on pesticide degradation, persistence, and movement. All parameters affect pesticide persistence. Irrigation and rainfall showed considerable effect on pesticide movement in various soil types. A third project examined the movement of contaminants from selected municipal landfills into adjacent shallow groundwater. Toxicological studies were performed examining the effect of herbicides and combinations on toxicity parameters in animals. At the levels found environmentally in North Dakota no overt toxic symptoms have been observed. However, experiments performed using artificially produced mixtures of selected pesticides did yield results showing toxicity at high (or pharmacological) doses. A case study approach was used to evaluate the number of protected and threatened wetlands in North Dakota. In depth study of two counties revealed that 60% of the wetland acres were privately owned but that 90% were protected by various Federal and State agreements. These results will be helpful in shaping new legislation regarding wetlands. In addition, two graduate students were supported by special fellowships from the NDWRRI. Mr. Robert Kolberg was involved with the project to study the influence of irrigation and rainfall on the movement of pesticides through sandy, loam soil. Mr. Jeff Hendrickson was involved in the ecological investigation of lakes, rivers, and impoundments in North Dakota. Information transfer activities included: sponsoring WET workshops, co-sponsoring a North Dakota Ground Water Quality Symposium, publication of two technical reports, several scientific manuscripts, and presentations at national meetings. Twelve students (5 undergraduate, 5 M.S., 2 Ph.D.) were supported by funding under this grant. (USGS)
W90-05225

FISCAL YEAR 1988 REPORT (ARIZONA WATER RESOURCES RESEARCH CENTER).

Arizona Water Resources Research Center, Tucson.

W. B. Lord.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-124454/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1548-01, July 1989. 40p, 5 tab. USGS Contract 14-08-0001-G1548. USGS Project G1548-01.

Descriptors: *Water research institute, *Arizona, *Research, *Information transfer, *Training, *Education, *Projects.

Field 9—MANPOWER, GRANTS AND FACILITIES

Group 9D—Grants, Contracts, and Research Act Allotments

This report describes the institute's fiscal year 1988 Water Resources Research Act, Section 104 program activities. The research projects summarized in the report addressed the following critical water issues in Arizona: Water conservation (projects 03 and 06), water quality (project 05), and water management (projects 02, 04 and 07). Project 03 is developing salt-tolerant strains of alfalfa capable of germinating, emerging, and establishing when brackish water is used for irrigation. Project 06 developed efficient nursery production schemes for new desert plant species whose use in landscaping could produce significant water savings. Project 05 provides a systematic data base of radon gas in domestic water of the Tucson area. Project 02 is designed to identify the conjunctive and integrated water management option for the Phoenix Active Management Area which maximizes total benefits from all sources of water less total costs of groundwater overdraft, enforcement of water rights, and opportunity costs. Project 04 provides a state-of-knowledge assessment of the processes in a unified hydrological flow model, with emphasis on the three physiographic provinces of Arizona. Project 07 is developing a rainfall-runoff model for flash flood forecasting applicable to watersheds in the arid southwest. The information transfer component of the institute continued to publish newsletter and issue papers and sponsored workshops and conferences. (USGS) W90-05226

FISCAL YEAR 1988 PROGRAM REPORT (STATE OF WASHINGTON WATER RESEARCH CENTER).

Washington State Water Research Center, Pullman.

W. H. Funk.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129172/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1597-01, July 1989. 23p, 2 tab. USGS Contract 14-08-0001-G1597. USGS Project G1597-01.

Descriptors: *Water research institute, *Washington, *Research, *Information transfer, *Training, Education, Projects.

Nineteen dams and hydropower systems provide 80% of the power needs of the Pacific Northwest and the state of Washington. Water from the Columbia-Snake River watersheds irrigates over 4.9 million acres of farmland, with another 1.2 million acres being considered. The 50,000 miles of streams and 8,000 freshwater lakes play a major role in the social, recreational, and economic structure of the state. Recent droughts have shown that under low-water conditions allocations are not sufficient for all users. A major commitment of the state water agencies and the public is to preserve the migration of anadromous fishes in the Pacific Northwest rivers as well as enhancing the recreation value and safe usage of the surface and groundwater of the state. Funding from state agencies during FY88 allowed the Water Research Center to conduct a water use efficiency study. Results of the study are being used to incorporate changes in state water law. Projects funded through the Water Resources Research Program such as the expert system for drought management planning and the deficit or partial irrigation studies directly aid in development of strategies to alleviate water shortages. High erosion rates, agricultural drainage, and increased use of rivers for water transportation and recreation as well as for industrial and municipal wastes disposal are reducing the surface water and groundwater quality in many areas of the state. Research has shown that standard batch equilibrium tests overestimate the retention of pesticides by many soils and that migration may be up to seven times greater when dynamic tests are used. This work has also shown that each soil group must be evaluated separately for accurate prediction of pesticides movement. Deficit irrigation can greatly reduce contamination of surface and groundwater as well as reduce soil erosion. Other research has shown that high-rate application of phosphorus fertilizers to former or existing orchard sites significantly enhances the rate of arsenic leaching and migration to ground-

water. The State of Washington Water Research Center program is directed toward informing, educating, and attempting to solve or mitigate these complex water contamination, allocation, use, and reuse issues. These goals are carried out through publication of research results, conferences, workshops, and presentations. (USGS) W90-05227

FISCAL YEAR 1988 INSTITUTE PROGRAM REPORT (ARKANSAS WATER RESOURCES RESEARCH CENTER).

Arkansas Univ., Fayetteville. Water Resources Research Center.

K. F. Steele.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129198/AS. Price codes: A03 in paper copy, A01 in microfiche. Report G1549-01, June 1989. 38p. USGS Contract 14-08-0001-G-1549. USGS Project G-1549-01.

Descriptors: *Water research institute, *Arkansas, *Research, *Information transfer, *Training, Education, Projects.

Some of the major water resource problems in Arkansas are: (1) lowering of groundwater levels in eastern and southern Arkansas, (2) groundwater pollution, (3) determination of minimum instream flows, and (4) decrease in wetlands. The five research and two information management system projects supported by the Center for this year focused on problems (1) and (2). A total of 14 students (3 undergraduate and 11 graduate) gained training in these projects. Because Arkansas is an agricultural based state, it is not surprising that four (out of five) research projects were concerned with agricultural topics. Three projects dealt with agricultural contamination of water (especially groundwater) by disposal of poultry litter and use of pesticides. Another studied methods of improving irrigation scheduling and water efficiency in cotton production. The fifth research project developed an expert system to serve as a management tool for the operation of an activated sludge treatment plant. A pilot relational database for groundwater in Arkansas was developed by one of the two information management system projects. The other information management system project investigated the use of verified alga taxa as reference sources. (USGS) W90-05228

FISCAL YEAR 1988 PROGRAM REPORT (NEVADA WATER RESOURCES RESEARCH CENTER).

Nevada Univ., Reno. Center for Water Resources Research.

J. W. Hess.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129180/AS. Price codes: A03 in paper copy, A01 in microfiche. Desert Research Institute, Program Report G1575-01, July 1989. 27p. USGS Contract 14-08-0001-G-1575. USGS Project G-1575-01.

Descriptors: *Water research institute, *Nevada, *Research, *Information transfer, *Training, Education, Projects.

Nevada is one of the fastest growing states in the nation with most of the population concentrated in two urbanized areas. Providing the water supply to meet the demands of these two growing urban areas is a challenging problem. Both areas are faced with prospects of having to develop additional facilities for increasing water supplies from various sources. The purpose of one research project is to develop a methodology to determine capacity expansion of municipal water supply systems through optimal sequencing of water projects. Non-potable urban water reuse has the potential for supplementing water supplies and decreasing municipal water costs. One research project is investigating an economical means of upgrading wastewater effluents for water reuse. Conflicts in the utilization of groundwater often occur when questions arise as to whether the water is of recent atmospheric origin, or was deposited decades ago. One project seeks to develop an

alternative method for dating groundwater, in addition to the well established tritium method. The issue of groundwater quality and quantity is a major concern for those entities managing this limited resource. Excess waters applied to the land surface may infiltrate through the soil conducting chemical constituents to underlying aquifers. One research project has been undertaken to characterize the chemical and hydraulic nature of the shallow aquifer zone to assess the potential impact on the groundwater production zone of the valley aquifer. Nevada, along with other states in the arid southwest, has communities with undesirably high arsenic levels. One research project was aimed at development of a feasible method of arsenic removal from drinking water. (USGS) W90-05229

FISCAL YEAR 1988 PROGRAM REPORT (MISSOURI WATER RESOURCES RESEARCH CENTER).

Missouri Water Resources Research Center, Columbia.

T. E. Clevenger.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129164/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1572-01, June 1989. 23p. USGS Contract 14-08-0001-G-1572. USGS Project G-1572-01.

Descriptors: *Water research institute, *Missouri, *Research, *Information transfer, *Training, Education, Projects.

The Missouri Water Resources Research Center's goals are (1) to establish research programs that will assist in the study of Missouri's water problems, (2) to provide an educational program that offers graduate students, with an interest in water or related fields, the opportunity to continue their education in these areas, and (3) to be actively dedicated to the dissemination of information through all aspects of the media in reaching the researcher, users and citizens of Missouri with informative water related news and research ideas on the future of Missouri's water. Areas of research covered under this grant include: (1) field evaluation of calibration for agricultural pesticide transport to groundwater, Phase II, (2) field evaluation of termiticide movement, Phase II, (3) transport of nitrates in Missouri River Valley loess deposits, (4) nitrate removal by denitrification using 'Captor' media and (5) degrading sludge with cellulase complex. A total of 10 students, 7 graduate students and 3 undergraduate students, were involved in this year's research programs. (USGS) W90-05230

FISCAL YEAR 1988 PROGRAM REPORT (OKLAHOMA WATER RESOURCES RESEARCH INSTITUTE).

Oklahoma State Univ., Stillwater. Univ. Center for Water Research.

N. N. Durham.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-129123/AS. Price codes: A03 in paper copy, A01 in microfiche. Report G1608-01, July 1989. 42p. USGS Contract 14-08-0001-G-1608. USGS Project G-1608-01.

Descriptors: *Water research institute, *Oklahoma, *Research, *Information transfer, *Training, Education, Projects.

The FY 1988 Oklahoma Water Resources Research Institute research program addressed the issues of surface and groundwater quality and management of water resources with emphasis on the determination of water quality and remediation of water resources determined to be contaminated. Task 1 administered the program and conducted information transfer activities such as continued publication of the newsletter, publication of a collection of papers on groundwater quality, publication of a methodology to characterize landfill sites, and updating a directory of water professionals in Oklahoma. Task 2 investigated the risks to groundwater quality associated with pesticide use. Task 3

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examined the cause and effect of rapid changes in shallow groundwater quality. Task 4 developed a modeling tool to improve surface runoff prediction from ungaged, non-urban sites. Task 5 began the development of biofilms capable of biodegradation of pollutants. Task 6 investigated the effects of agricultural impacts on water quality. Task 7 developed procedures to incorporate risk analysis into the design processes for water resources facilities. (USGS)
W90-05231

10. SCIENTIFIC AND TECHNICAL INFORMATION

10B. Reference and Retrieval

INDEXES OF HYDROLOGIC DATA FROM SELECTED COAL-MINING AREAS IN NORTH-WESTERN COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-05217

10C. Secondary Publication And Distribution

ABSTRACTS OF PUBLICATIONS AND PRESENTATIONS: 1985-1986.
Environmental Protection Agency, Washington,

DC. Office of Acid Deposition, Environmental Monitoring, and Quality Assurance.
For primary bibliographic entry see Field 5B.
W90-05165

PETROLEUM FATE AND CLEANUP AGENT TOXICOLOGY: AN ANNOTATED BIBLIOGRAPHY.
California Univ., Santa Cruz. Center for Marine Studies.
For primary bibliographic entry see Field 5B.
W90-05583

EPA TREATABILITY DATABASE.
Radian Corp., Milwaukee, WI.
For primary bibliographic entry see Field 5D.
W90-05588

10D. Specialized Information Center Services

ENGINEERS AND OPERATORS NETWORK.
For primary bibliographic entry see Field 7C.
W90-04577

10F. Preparation Of Reviews

SPECIFICITY OF THE DPD AND AMPEROMETRIC TITRATION METHODS FOR FREE AVAILABLE CHLORINE: A REVIEW.

State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-04812

EPIDEMIOLOGY AND TOXICOLOGY OF VOLATILE ORGANIC CHEMICAL CONTAMINANTS IN WATER ABSORBED THROUGH THE SKIN.
National Academy of Sciences, Washington, DC.
For primary bibliographic entry see Field 5C.
W90-04830

AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE: A REVIEW.
For primary bibliographic entry see Field 5E.
W90-04906

QUANTITATION OF ACRYLAMIDE (AND POLYACRYLAMIDE): CRITICAL REVIEW OF METHODS FOR TRACE DETERMINATION/FORMULATION ANALYSIS AND FUTURE-RESEARCH RECOMMENDATIONS.
For primary bibliographic entry see Field 5A.
W90-05147

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W90-04832 5B

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Abstracts of Publications and Presentations: 1985-1986.
W90-05165 5B

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Watershed Acidification Models Using the Knowledge-Based Systems Approach.
W90-05043 5C

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W90-05048 5C

Dissolution of Calcite in Acid Waters: Mass Transport Versus Surface Control.
W90-05362 5G

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Research on Metals in Acid Mine Drainage in the Leadville, Colorado, Area.
W90-05066 5B

Instream Chemical Reactions of Acid Mine Water Entering a Neutral Stream Near Leadville, Colorado.
W90-05067 5B

Heavy-Metal Geochemistry of Sediments in the Pueblo Reservoir, Colorado.
W90-05068 5B

Metal Partitioning and Photoreduction of Iron in Filtrates of Acid Streamwater, St. Kevin Gulch, Leadville, Colorado.
W90-05069 5B

Partitioning of Metals Between Water and Flocculated Bed Material in a Stream Contaminated by Acid Mine Drainage near Leadville, Colorado.
W90-05070 5B

Colloidal Properties of Flocculated Bed Material in a Stream Contaminated by Acid Mine Drainage, St. Kevin Gulch, Colorado.
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Preliminary Assessment of the Effects of Acid Mine Drainage on Ground Water Beneath a Wetland Near Leadville, Colorado.
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Research Activities Related to Acidic Water Near Globe, Arizona.
W90-05125 5B

Status Report on a Study of the Effects of Acid Mine Drainage on Vegetation Near Leadville, Colorado.
W90-05128 5C

Chemical, Geologic, and Hydrologic Data from the Study of Acidic Contamination in the Miami Wash-Pinal Creek Area, Arizona, Water Years 1984-87.
W90-05187 5B

Hydrologic Data Collected in the Vicinity of the Proposed Gamma-Ray and Neutrino Detector Site, Hot Spring County, Arkansas, 1988-89.
W90-05268 2F

Preliminary Results of an Experiment to Assess the Effect of Substrate Type on Treatment of Acid Drainage Using Constructed Wetlands.
W90-05559 5C

Chemical, Geologic, and Hydrologic Data from the Study of Acidic Contamination in the Miami Wash-Pinal Creek Area, Arizona, Water Years 1984-87.
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Acid Deposition Modeling and the Interpretation of the United Kingdom Secondary Precipitation Network Data.
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W90-04894 7B

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W90-05043 5C

Abstracts of Publications and Presentations: 1985-1986.
W90-05165 5B

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W90-04618 5B

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W90-04622 5B

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W90-04656 5C

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W90-04670 5C

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W90-04709 2H

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W90-05275	2K	W90-05359	2H	W90-05443	3A	W90-05527	5C
W90-05276	7A	W90-05360	2H	W90-05444	3C	W90-05528	8I
W90-05277	5B	W90-05361	2H	W90-05445	3A	W90-05529	8I
W90-05278	5A	W90-05362	5G	W90-05446	3A	W90-05530	8I
W90-05279	6D	W90-05363	2H	W90-05447	5D	W90-05531	8I
W90-05280	2K	W90-05364	2H	W90-05448	8I	W90-05532	8I
W90-05281	2E	W90-05365	5B	W90-05449	8I	W90-05533	2L
W90-05282	2F	W90-05366	5B	W90-05450	5B	W90-05534	2L
W90-05283	2F	W90-05367	5B	W90-05451	2H	W90-05535	2L
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W90-05287	2L	W90-05371	2H	W90-05455	2H	W90-05539	2L
W90-05288	2B	W90-05372	5C	W90-05456	2H	W90-05540	2L
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W90-05290	2F	W90-05374	5B	W90-05458	2H	W90-05542	2L
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W90-05293	2F	W90-05377	5C	W90-05461	2H	W90-05545	2L
W90-05294	2H	W90-05378	5C	W90-05462	2H	W90-05546	2J
W90-05295	5G	W90-05379	5C	W90-05463	2H	W90-05547	2A
W90-05296	2H	W90-05380	2H	W90-05464	2H	W90-05548	2A
W90-05297	2L	W90-05381	2C	W90-05465	2H	W90-05549	2E
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1990 Price Schedules for the United States, Canada, and Mexico

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A10-A1331.00	E0621.50	D06280	T06670
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